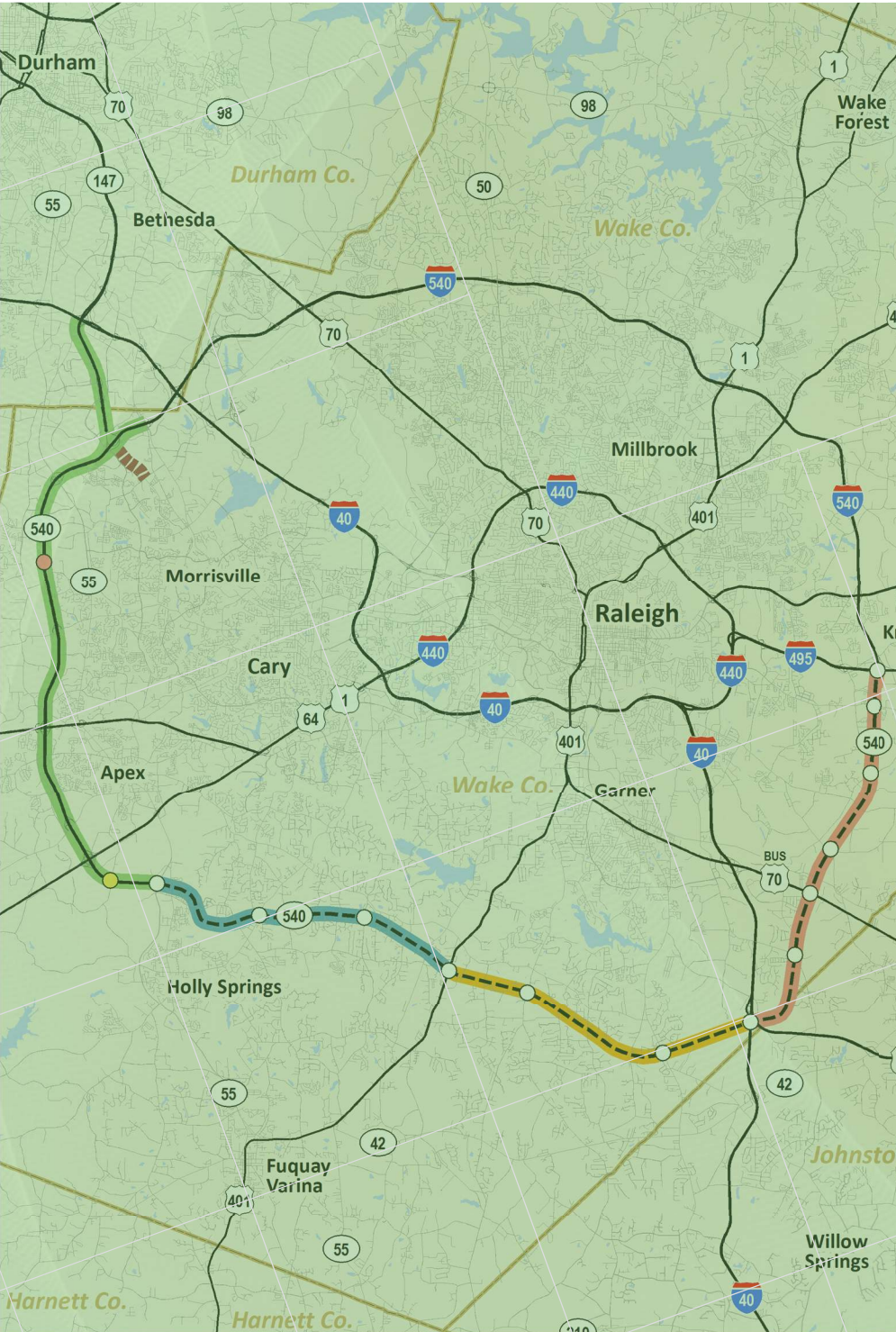


Complete 540 Planning Level Traffic and Revenue Study



COMPLETE 540

**TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION**



May 2017



Prepared for
**North Carolina
Department of Transportation**



**CDM
Smith**

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Chapter 1 - Draft

Introduction

This study had two primary purposes, as defined by the North Carolina Turnpike Authority (NCTA). The first purpose was to develop an updated traffic and toll revenue forecast for the existing Triangle Expressway. The second purpose was to develop traffic and toll revenue forecasts for three Complete 540 scenarios, a proposed toll road also known as the Southeast Extension. The projects are shown in **Figure 1.1**. Complete 540 will extend the Triangle Expressway from the NC 55 Bypass in Apex to the U.S. 64/U.S. 264 Bypass in Knightdale, completing the 540 Outer Loop around the greater Raleigh area. There are three construction segments of Complete 540, shown as Segments 1, 2, and 3 in Figure 1.1. This study analyzed the traffic and toll revenue potential of constructing Segment 1 by 2025, compared to constructing Segments 1 and 2 by 2025, and the additional impact of Segment 3 added in 2030.

Annual traffic and toll revenue forecasts are provided from 2017 through 2055. Forecasts are provided for the Triangle Expressway (Scenario 1) and for the Complete 540 Scenarios 2, 3, and 4, all of which include the traffic and toll revenue generated by the Triangle Expressway. Traffic and revenue impacts of Scenarios 2, 3, and 4 (Complete 540) compared to Scenario 1 are summarized. These forecasts are for planning purpose and are not sufficient for use in project financing.

The following describes the four scenarios that were evaluated in this study.

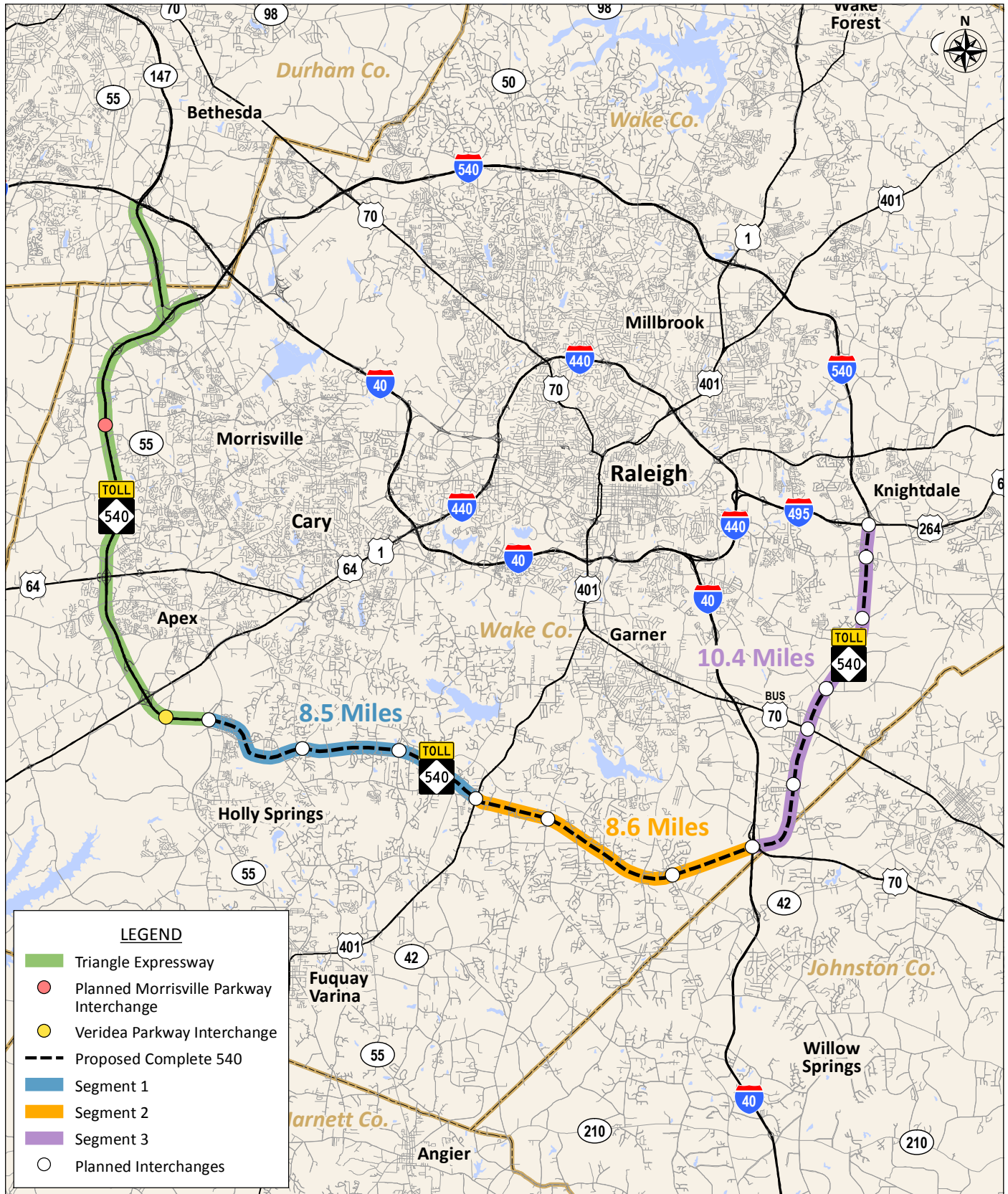
Scenario 1: Traffic and toll revenue estimates were developed for the existing Triangle Expressway, including the impacts of a planned interchange at Veridea Parkway (STIP R-2635D), previously known as the Old Holly Springs-Apex Road Interchange, and at Morrisville Parkway (STIP U-5315). The Veridea Interchange opened to traffic on April 3, 2017, and the Morrisville Parkway Interchange is assumed to open on January 1, 2019.

Scenario 1.1: This scenario is a sensitivity test of Scenario 1, consisting of adding a tolled extension of NC 147 southward from the Triangle Expressway to McCrimmon Parkway in Morrisville. The extension is assumed to open on January 1, 2019. This scenario is not included in Scenarios 1, 2, 3, or 4.

Scenario 2: This scenario consists of Scenario 1 with the addition of Complete 540 Segment 1 (from NC 55 Bypass to U.S. 401). January 1, 2025 is the assumed opening date of Segment 1.

Scenario 3: This scenario consists of Scenario 2 with the addition of Complete 540 Segment 2 (from U.S. 401 to Interstate 40). January 1, 2025 is the assumed opening date of both Segments 1 and 2. The purpose of this scenario is to isolate the impact of extending Complete 540 to Interstate 40, compared to Scenario 1, where Complete 540 extends only to U.S. 401.

Scenario 4: This scenario consists of Scenario 3 with the addition of Complete 540 Segment 3 (from Interstate 40 to U.S. 64/ 264 Bypass.). This last segment will complete the NC 540 outer loop. January 1, 2030 is the assumed opening date of Segment 3.



1.1 Work Scope

The following six tasks were conducted as part of this study. Although this is a planning level study, much of this work is appropriate to carry into a study suitable for support of project financing.

- Task 1: Data Collection and Summarization
- Task 2: Model Review and Refinement
- Task 3: Base Year Model Calibration
- Task 4: Project Configuration, Tolling Locations, and Model Inputs
- Task 5: Traffic and Toll Revenue Analysis
- Task 6: Study Documentation and Management

A description of each task is provided below.

1.1.1 Task 1: Data Collection and Summarization

The following data was collected for use in validating the regional demand model in the study area, understanding current traffic conditions, and identifying future road improvements.

Subtask 1.1: Traffic Counts

- CDM Smith obtained available traffic count data in the study area from the North Carolina Department of Transportation (NCDOT) and the NCTA.
- Toll transaction and toll revenue data for the Triangle Expressway from 2013 through 2016 was obtained from the NCTA.
- CDM Smith contracted The Traffic Group to conduct traffic counts at 63 locations in the study area. Most counts were conducted for 3 continuous weekdays, but 7-day counts were conducted at 12 key locations.

Subtask 1.2: INRIX/HERE Travel Speed Data

Travel speed data was obtained from both INRIX and HERE via the Regional Integrated Transportation Information System (RITIS) with the permission of the NCDOT. Travel speed information was collected for the 12-month period from October 2015 through September 2016.

Subtask 1.3: Origin and Destination Data

One full year of origin-destination data was obtained from StreetLight Data, Inc. The data provides insight into the travel patterns and trip distances in the study area.

Subtask 1.4: Roadway Improvements

CDM Smith reviewed road improvements that were assumed in the regional demand model. These improvements were compared against improvements in the following two documents.

1. ***Draft NCDOT 2017-2027 STIP (January 2017)***
2. ***NC Capital Area Metropolitan Planning Organization (CAMPO) 2040 Metropolitan Transportation Plan (Amended September 2015)***

The primary purpose of the review was to determine if changes needed to be made to the assumed future roadway improvements in the regional demand model, and to identify improvements that could either positively or negatively impact potential traffic volumes on the Triangle Expressway or Complete 540. Discussions were held with NCDOT staff to clarify roadway improvement plans.

1.1.2 Task 2: Model Review and Refinement

The Triangle Regional Model version 5 (TRMv5) was used to analyze the traffic and toll revenue potential of the study scenarios. CDM Smith reviewed the TRMv5 to identify changes that needed to be made to improve calibration to existing conditions, reflect future road way improvements, and reflect the configuration, alignment and capacity of the Triangle Expressway and the proposed Complete 540. In addition, CDM Smith reviewed the TRMv5 growth assumptions in households and employment in the study area.

1.1.3 Task 3: Base Year Model Calibration

The TRMv5 model was calibrated at certain key locations in the study area to 2016 actual conditions, based on traffic counts, travel time data, and origin-destination data.

1.1.4 Task 4: Project Configuration, Tolling Locations, and Model Inputs

The Complete 540 project alignment and configuration was obtained from the NCTA, along with the tolling concept. In addition, CDM Smith developed other model inputs including the market share of electronic toll collection (ETC) equipped vehicles on the Triangle Expressway and Complete 540, motorist values-of-time (VOT) and vehicle operating cost (VOC), and future toll rate schedules.

1.1.5 Task 5: Traffic and Toll Revenue Analysis

Traffic assignments were conducted for Scenarios 1, 1.1, 2, 3 and 4 at years 2016, 2017, 2019, 2025, 2030 and 2040. The assignments formed the basis for developing estimated annual toll transactions and toll revenue.

1.1.6 Task 6: Study Documentation and Management

Aside from this document, the following documents were provided electronically to the NCDOT/NCTA over the course of the study.

- The ***Traffic Count Program***, dated October 12, 2016. This document included traffic count location maps and a table describing the location and duration of the traffic counts conducted by The Traffic Group.
- The ***Technical Memorandum on Data Collection***, dated February 3, 2017. This document contained a summary of 1) the traffic count program conducted by The Traffic Group; 2) travel speed data from HERE and INRIX; and 3) StreetLight origin-destination data.

- The ***Technical Memorandum Complete 540 Planning Study – Modeling Scenarios, Project Configuration and Roadway Improvements***, dated March 15, 2017. This document summarized the modeling scenarios, the project alignments, number of through lanes, and assumed roadway improvements.

1.2 Prior Work

CDM Smith has conducted many studies on the Triangle Expressway, and a few planning level studies on various sections of proposed loop roads around Raleigh. The following lists the most pertinent Triangle Expressway Studies, and the most recent study (May 2008) that evaluated the toll revenue potential of various loop roads in the Raleigh area. The second study in the list, the ***2009 Comprehensive Report***, remains the most recent certified forecast of Triangle Expressway traffic and toll revenue. The study results were based on a TRM version that relied on 2000 Census data. The other studies listed are all planning level studies, based on the ***2009 Comprehensive Study***. The listed studies were used in the conduct of the current ***Complete 540 Planning Level Study***.

May 2008: NC Urban Loop Update and Ranking Study

Provided preliminary traffic and toll revenue forecasts for loop-road sections in the Raleigh area, including the Complete 540.

4/6/2009: Triangle Expressway Comprehensive Traffic and Revenue Study (2009 Comprehensive Report)

This report contains the most recent certified forecast of Triangle Expressway traffic and toll revenue. It contains forecasts for fiscal years (FY) 2012 through 2051, and was prepared prior to the opening of the Triangle Expressway. The forecasts did not include the Veridea Parkway or Morrisville Parkway interchanges.

October 2010: Triangle Expressway Veridea Interchange Test

This document presents planning level traffic and revenue estimates for the Veridea Parkway Interchange. It was based on the ***2009 Comprehensive Report***.

December 2010: Morrisville Parkway Interchange Test

This document presents planning level traffic and revenue estimates for the Morrisville Parkway Interchange. It was based on the ***2009 Comprehensive Report***.

11/10/2011: Toll 147/McCrimmon Parkway Connector T&R Study

This document presents planning level traffic and revenue estimates for the Toll 147 extension to McCrimmon Parkway. It was based on the ***2009 Comprehensive Report*** and did not assume the Veridea Parkway or Morrisville Parkway interchanges.

4/25/2012: Technical Memorandum – 24 Month Monthly Transactions and Gross Toll Revenue Estimates for the Triangle Expressway

This document presents revised traffic and toll revenue estimates from January 2012 through December 2014 to reflect changes in the actual phased opening of the Triangle Expressway. The estimates were based on the ***2009 Comprehensive Report***. The

Veridea Parkway and Morrisville Parkway interchanges were not included in the forecasts.

9/9/2013 *Impact of Morrisville Parkway and Old Holly Springs Road Interchanges*

Revised traffic and toll revenue forecasts are provided for the Triangle Expressway without the proposed interchanges, with each individual interchange, and with both interchanges. The Old Holly Springs-Apex Road Interchange was the current name for the Veridea Interchange at the time of the study. The revisions of the Triangle Expressway included adjustments for actual experience, and some toll schedule adjustments that reflected actual phased openings. Both interchanges were assumed to open on January 1, 2016. The forecasts were based on the **2009 Comprehensive Report**.

03/31/2016 *Toll NC 540/Old Holly Springs Road Interchange Toll Schedule Recommendation*

Provided the recommended toll rate schedule for the Veridea Parkway interchange (previously the Old Holly Springs Road Interchange). This toll rate schedule differed slightly from the assumed toll rates in the 9/9/2013 letter listed above. The recommended Veridea toll rate schedule was adopted by the NCDOT.

3/22/2017 Revised transactions and toll revenue forecasts were prepared for the Triangle Expressway and for impacts due to the Veridea Parkway and Morrisville Parkway interchanges to reflect opening dates of April 1, 2017 and January 1, 2019, respectively. The revised transaction and revenue forecasts were used in the ***North Carolina Turnpike Authority Triangle Expressway Senior Lien Turnpike Revenue Refunding Bonds Official Statement***. The revised forecasts were based on the **2009 Comprehensive Report**.

1.3 Report Structure

The remainder of this report consists of three chapters.

Chapter 2: Existing Conditions

This Chapter describes the existing conditions and collected data in the study corridor. This includes conditions on the Triangle Expressway, traffic volumes on other area roads, travel times, and the collection of origin-destination data.

Chapter 3: Model Review and Refinement

This Chapter describes the regional travel demand model and the refinements that were made to the model.

Chapter 4: Traffic and Toll Revenue Analysis

This Chapter describes the model inputs and basic study assumptions. It also summarizes how the model output is converted into annual traffic and toll revenue forecasts. Annual forecasts are provided for each scenario. In addition, comparisons are made between scenarios to highlight traffic and toll revenue impacts.

Chapter 2 - Draft

Existing Conditions

This Chapter describes 2016 existing conditions for the Triangle Expressway and other area roads. Data is provided for traffic volumes, travel times, and the collection of origin-destination data.

2.1 The Triangle Expressway

The existing Triangle Expressway is an approximately 18.5 mile, limited access toll road consisting of three through travel lanes per direction, and a posted speed limit of 70 mph. The road provides a high-speed connection from communities to the south and west of Raleigh, such as Fuquay Varina, Holly Springs, and Apex, to Interstate 40 (I-40), Research Triangle Park (RTP) and the Raleigh-Durham International Airport. The Triangle Expressway is designated as Toll 540, and is part of the 540 Outer Loop. The primary competing roadway is NC 55, which closely parallels the Triangle Expressway. NC 55 generally provides two through travel lanes per direction, with the intermittent provision of left, right and center turn lanes. There are some single-lane sections of NC 55. The posted speed limits range from 35 to 55 mph on NC 55 in the Triangle Expressway corridor.

The Triangle Expressway opened in three phases, as shown in **Table 2.1**. The entire project was opened to tolled traffic on January 2, 2013. The most recent improvement to the Triangle Expressway was the full-access interchange with Veridea Parkway which opened on April 4, 2017.

Table 2.1
Triangle Expressway (Toll 540) Construction History

Improvement	Opening Date	Tolling Began	Location
Phase I	December 8, 2011	January 3, 2012	NC 540 between NC 55 and NC 54 NC 147 between I-40 and NC 540
Phase II	August 1, 2012	August 2, 2012	NC 540 between NC 55 and U.S. 64 in Apex
Phase III	December 12, 2012	January 2, 2013	NC 540 between U.S. 64 and NC 55 Bypass near Holly Springs
Veridea Interchange	April 4, 2017	April 4, 2017	Full access interchange at NC 540 and Veridea Parkway.

2.1.1 Toll Collection and Toll Schedule

The Triangle Expressway features an all-electronic tolling system (AET), designed to reduce traffic delays and promote safety. This system allows motorists to pay their toll without stopping or slowing down. Tolls are collected via NC Quick Pass, NCDOT's ETC program, or by a video toll collection system named Bill by Mail (BBM). No conventional toll plazas are located on the Triangle Expressway; instead, toll collection equipment is located on gantries elevated over the road. The NC Quick Pass program is currently interoperable with Georgia's Peach Pass, Florida's Sun Pass and E-ZPass.

The toll schedule is comprised of the following three toll classes:

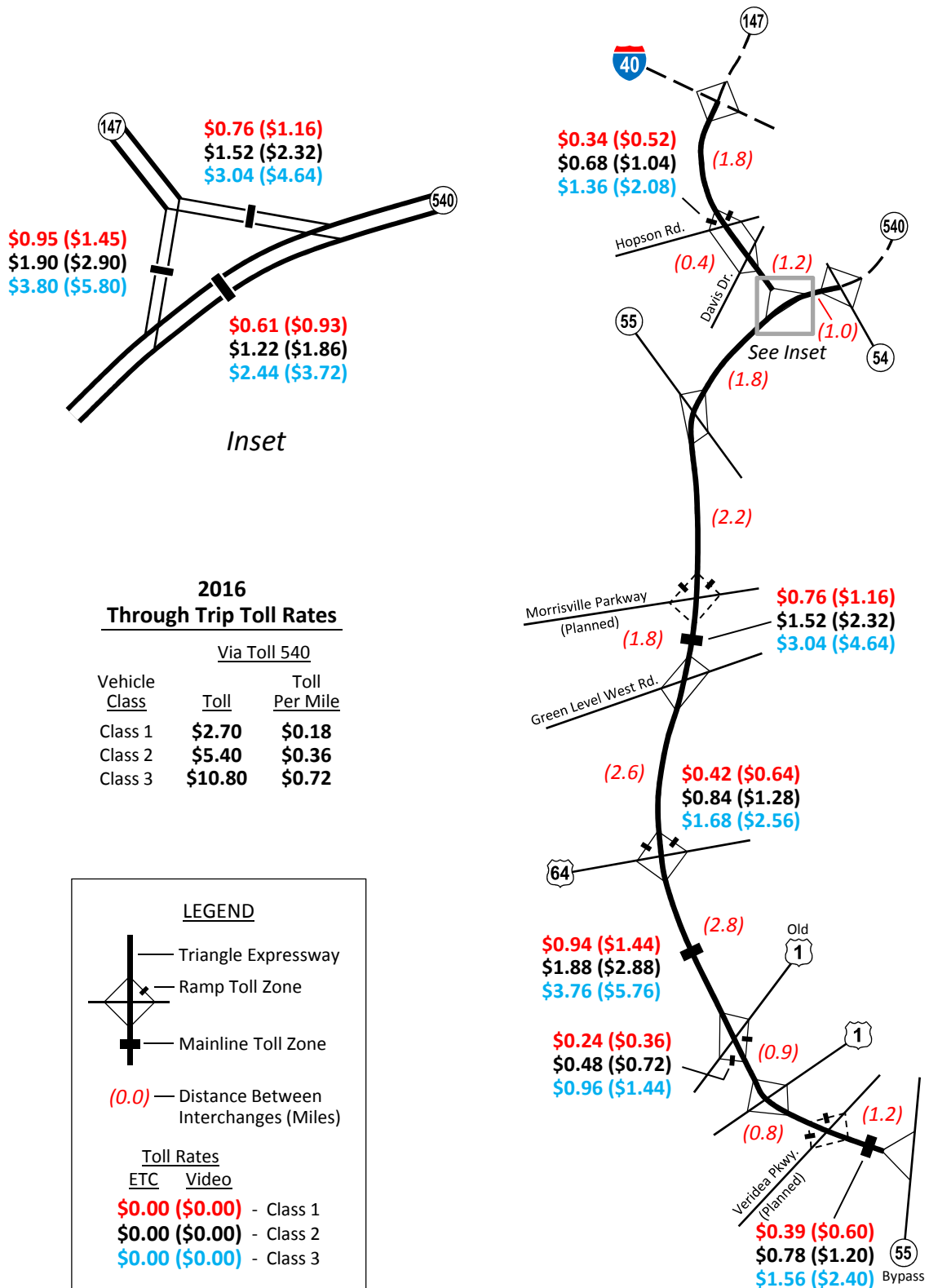
- Class 1 (2-axle vehicles): includes all two-axle vehicles regardless of the number of tires.
- Class 2 (3-axle vehicles): includes all three-axle vehicles including two-axle vehicles towing a single-axle trailer.
- Class 3 (4-or-more axle vehicles): includes all vehicles with four-or-more axles (4+) including two-axle vehicles towing a dual-axle trailer.

Motorists who pay with NC Quick Pass (or interoperable systems) receive a 35 percent discount from the video rates for all vehicle toll classes. Class 2 toll rates equal two times the Class 1 toll rate, and Class 3 toll rates equal four times the Class 1 toll rate. **Figure 2.1** shows the toll zones on the Triangle Expressway, and the 2016 ETC and video toll rates at each location. 2016 toll rates are shown because the regional demand model was calibrated to 2016 conditions. In 2016, a passenger-car motorist making a through trip on Toll 540 equipped with a transponder would have paid \$2.70, which equals \$0.18 per mile. A 5-axle truck making the same trip would have paid \$10.80, or \$0.72 per mile.

2.1.2 2016 Traffic Volumes on the Triangle Expressway

The NCTA provided CDM Smith with traffic volume data on the Triangle Expressway at both tolled and non-tolled locations. The following sources of data were used as part of this study:

1. The NCTA *Quarterly Operations and Statistics Report*, that is available on the NCDOT website.
2. A database of all transactions for one 24-hour weekday in November 2016, by method of payment, vehicle class, and toll zone.
3. A daily summary of all transactions in 2016 by toll zone and by vehicle class.
4. A daily summary of all transactions in 2016 by toll zone and by method of payment.
5. A monthly summary of systemwide transactions from January 2013 through December 2016.



**TRIANGLE EXPRESSWAY:
2016 ETC AND VIDEO TOLL RATES**

Based on the data described above, CDM Smith developed a balanced profile of 2016 average weekday traffic on the Triangle Expressway as shown in **Figure 2.2**. Traffic volumes build steadily from the south to the north end of the Triangle Expressway, ranging from 17.8 thousand vehicles per weekday at the southernmost mainline section to 45.4 thousand on the mainline section between NC 55 and Toll 147.

Also shown in Figure 2.2 is the hourly weekday traffic distribution, by direction, at each of the four, mainline toll-zone locations. The hourly, directional traffic distributions are based on traffic data from Thursday, November 10, 2016. There is a sharp peaking characteristic to Triangle Expressway traffic, consistent with a commuter-based road. Mainline northbound traffic peaks during the morning, while southbound mainline traffic peaks during the afternoon and evening on the Triangle Expressway.

Northbound mainline traffic generally peaks between 7 and 9 AM, with traffic totaling about 32 to 37 percent of the total northbound traffic at the four mainline locations shown in Figure 2.2. AM peak-hour traffic occurs between 7 and 8 AM, representing 15 to 20 percent of the total northbound traffic at the four mainline locations. Southbound mainline traffic on the Triangle Expressway peaks sharply from 5 to 6 PM, comprising 16 to 22 percent of the weekday southbound traffic, as seen at the selected locations. PM peak period traffic, between 4 to 7 PM in the southbound direction, accounts for 40 to 47 percent of weekday southbound traffic.

2.1.3 2016 Traffic Characteristics on the Triangle Expressway

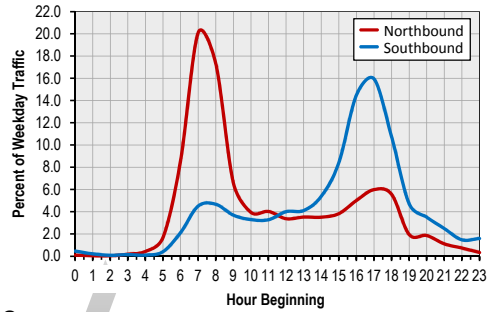
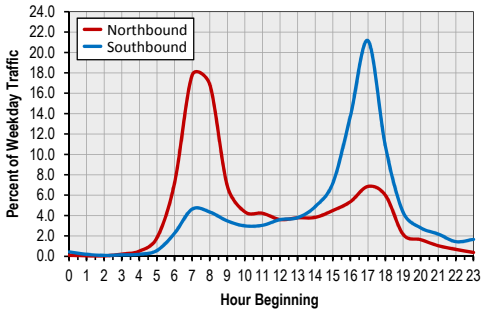
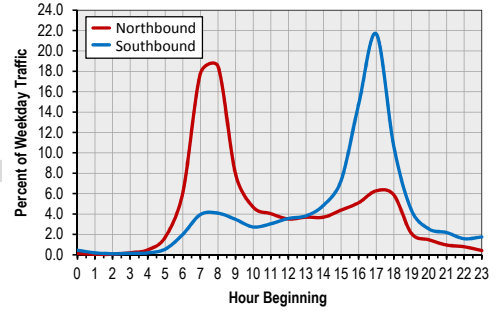
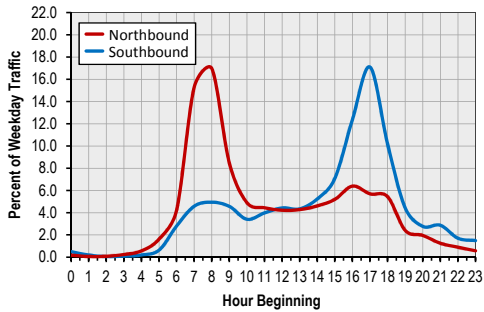
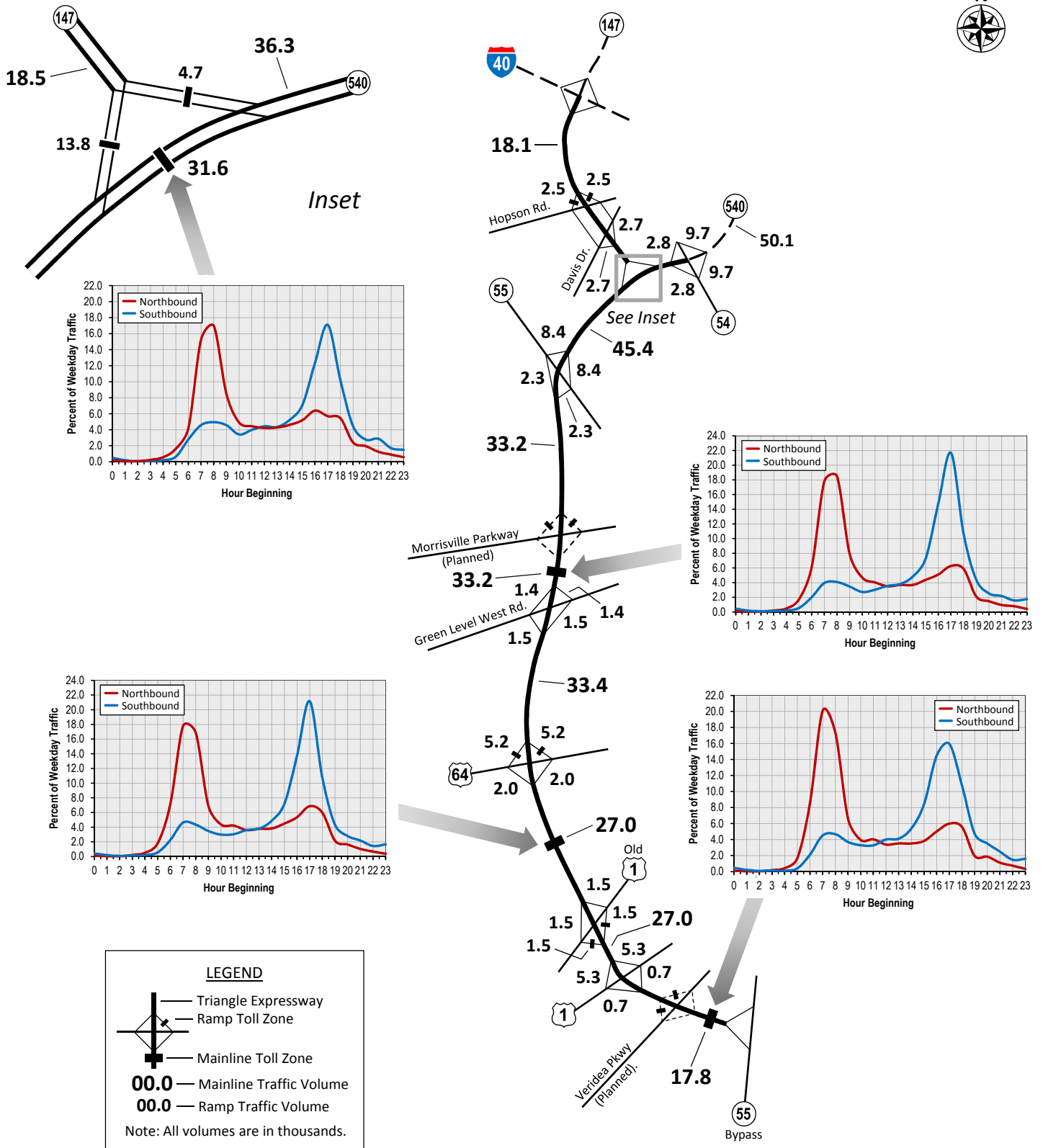
Passenger cars (Class 1 vehicles) make up the clear majority of transactions on the Triangle Expressway, both for ETC and video transactions. As shown in **Table 2.2**, passenger cars comprised about 97 percent of all ETC transactions and about 96 percent of all video transactions in 2016. The percent passenger cars and trucks has been stable over the lifetime of the Triangle Expressway.

Table 2.2
Percent Car and Truck Distribution
on the Triangle Expressway

Calendar Year	Transactions								
	Electronic Toll Collection (ETC)			Video			Total		
	Cars	Trucks	Total	Cars	Trucks	Total	Cars	Trucks	Total
2013	97.2	2.8	100.0	96.0	4.0	100.0	96.7	3.3	100.0
2014	97.2	2.8	100.0	96.0	4.0	100.0	96.7	3.3	100.0
2015	97.2	2.8	100.0	95.9	4.1	100.0	96.7	3.3	100.0
2016	96.9	3.1	100.0	95.5	4.5	100.0	96.3	3.7	100.0

Note: Cars are Class 1 vehicles
Trucks are Class 2 and Class 3 vehicles

Source: NCTA



LEGEND

- Triangle Expressway
- Ramp Toll Zone
- Mainline Toll Zone
- 00.0** Mainline Traffic Volume
- 00.0** Ramp Traffic Volume

Note: All volumes are in thousands.

TRIANGLE EXPRESSWAY: 2016 AVERAGE WEEKDAY TRAFFIC AND HOURLY DISTRIBUTION



FIGURE 2.2

The annual method-of-payment distribution for toll transactions is shown in **Table 2.3**. In 2016, 59 percent of passenger cars paid tolls via ETC, the remaining 41 percent paid via video. Forty-nine percent of trucks paid by ETC and 51 percent by video. The percent market share of ETC and video has remained consistent from 2013 through 2016.

Calendar Year	Transactions								
	Cars			Trucks			Total		
	ETC	Video	Total	ETC	Video	Total	ETC	Video	Total
2013	57.8	42.2	100.0	48.8	51.2	100.0	57.5	42.5	100.0
2014	58.4	41.6	100.0	48.7	51.3	100.0	58.1	41.9	100.0
2015	58.0	42.0	100.0	48.1	51.9	100.0	57.6	42.4	100.0
2016	58.6	41.4	100.0	49.0	51.0	100.0	58.3	41.7	100.0

Note: Cars are Class 1 vehicles
Trucks are Class 2 and Class 3 vehicles

Source: NCTA

2.1.4 Annual Transaction and Toll Revenue Trends on The Triangle Expressway

The Triangle Expressway has been in operation since December 8, 2011, although the complete road was not opened to traffic until December 12, 2013. Annual toll transactions and gross toll revenue from 2013 through 2016 are shown in **Table 2.4**. Strong growth has occurred in transactions and toll revenue, due to demographic and economic growth in the study area, and as motorists have become familiar with the new road and its benefits. Annual gross toll revenue increased at a faster rate than transactions due in part to a programmed increase in annual toll rates on the Triangle Expressway. Toll rates increased, on average, by 5 percent beginning in early January 2015 and 2016.

Calendar Year	Toll Transactions and Year over Year Percent Growth		Gross Toll Revenue and Year over Year Percent Growth (1)	
	Transactions	Growth	Revenue	Growth
	2013	23,059		\$14,238
2014	30,650	32.9 %	21,045	47.8 %
2015	38,319	25.0	28,779	36.7
2016	45,244	18.1	35,393	23.0

1) This is toll revenue collected during the indicated year. It does not include fee revenue.

Source: NCTA

Tables 2.5 and 2.6 present monthly transactions and gross toll revenue on the Triangle Expressway by payment type and vehicle class from 2013 through 2016, respectively. These tables show that while Class 1 vehicles comprised 96 percent of total transactions in 2016, they generated only 91 percent of the collected toll revenue due to the fact that Class 2 and 3 vehicles pay a higher toll. The remaining 7 percent of toll revenue was generated by Class 2 and 3 vehicles.

2.2 Traffic Volumes in the Study Area

CDM Smith collected a variety of traffic counts from different sources to validate the TRM's assigned weekday traffic volumes at locations in the study area. The following sources of traffic counts were used in this study:

1. CDM Smith had The Traffic Group conduct traffic accounts at 63 locations in the fall of 2016. These counts were conducted at sites where hourly traffic data was required.
2. Average annual daily traffic volumes were obtained from the NCDOT's Interactive Traffic Volume Map, located on the NCDOT website.
3. NCTA provided CDM Smith with turning movement counts and 48-hour classification counts in the study area conducted by HNTB.
4. As described in Section 2.1.2, the NCTA provided CDM Smith with traffic volume data on the Triangle Expressway at both tolled and non-tolled locations.

2.2.1 Traffic Counts Conducted by The Traffic Group

Traffic counts were conducted in the fall of 2016 by The Traffic Group at a total of 63 locations in the study corridor. Counts were collected by direction in 15-minute increments via tubes, or by Wavetronix radar detectors where tubes were not appropriate. Tube counts were collected by FHWA vehicle classifications. Wavetronix counts were collected by length categories. All counts were subsequently summarized into existing NCTA toll classes and Triangle Regional Model time periods. Counts were conducted for at least 3 continuous weekdays (Tuesday, Wednesday, Thursday). At 12 key locations, counts were conducted for 7 continuous days to obtain weekday and weekend day traffic volumes.

Count locations were organized into 8 screenlines, as shown in **Figure 2.3**. Screenlines 1 through 7, shown as green lines, represent groups of roads that parallel the Complete 540 preferred alignment or the existing Triangle Expressway. Screenline 8 contains count locations on roads that intersect or provide feeder routes to Complete 540 or the Triangle Expressway. Three additional counts were conducted on I-40 (locations 8.27, 8.28 and 8.29) that were not included in any screenlines. Figure 2.3 provides the location numbers for each count station. These location numbers are also shown in **Table 2.7**, which lists the count locations, the duration of the counts and the dates counts were conducted. **Table 2.8** provides a summary of the count program including average weekday traffic, average weekend day traffic, and the percent of truck traffic, defined as vehicles with three or more axles. Details of the traffic count program are provided in the CDM Smith Technical Memorandum *Complete 540 Planning Study – Data Collection*, dated February 3, 2017.

Table 2.6 Historical Gross Toll Revenue Collected on the Triangle Expressway (1)

Table with multiple columns: Month, ETC Revenue (Percent Change 2013-2016), Video Revenue (Percent Change 2013-2016), All Revenue (Percent Change 2013-2016). Rows include months from January to December for Toll Class 1, Class 2 & 3, and All Toll Classes, plus total years.

1) Unaudited Toll Revenue consisting of collected toll revenue during the indicated month. Collected toll revenue does not include any fee revenue.

Source: Data provided by the NCTA

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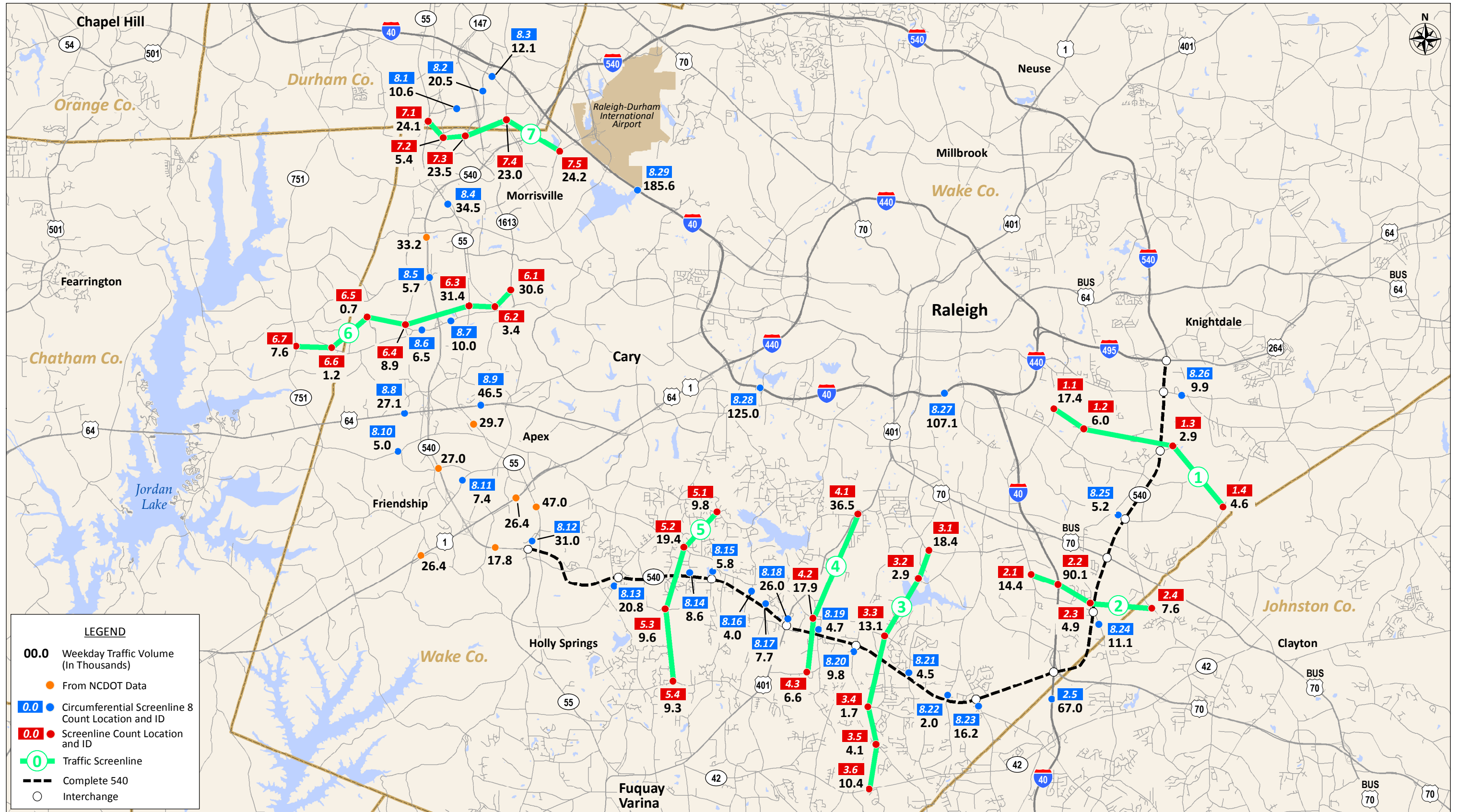


Table 2.7
Traffic Count Locations and Collection Dates (1)

Location #	Count Location	Data Collected Between These Crossroads		Count Duration	Collection Dates in 2016
		Crossroad 1	Crossroad 2		
Screenline 1: East Side of Raleigh, South of Pool Road					
1.1	S. New Hope Rd.	Rock Quarry Rd.	Maybrook Crossing Dr.	3-Day	11/1 - 11/3
1.2	Barwell Rd.	Tomahawk Trail	Holiday Dr.	3-Day	11/1 - 11/3
1.3	Auburn Knightdale Rd.	La Costa Way	Silver Star Dr.	3-Day	11/1 - 11/3
1.4	Mial Plantation Rd.	Old Baucomb Rd.	Nueshill Ln.	3-Day	11/15 - 11/17
Screenline 2: East side of Raleigh, South of Business 70					
2.1	White Oak Rd. (NC 2547)	Ackerman Rd.	Bryan Rd.	3-Day	11/1 - 11/3
2.2	Interstate 40	Business 70	US 70 (Clayton Bypass)	7-Day	10/18 - 10/24
2.3	Raynor Rd. (NC 2555)	White Oak Rd.	Twain Dr.	3-Day	11/1 - 11/3
2.4	Guy Rd. (NC 2558)	White Oak Circle	Golden Nugget Dr.	3-Day	11/1 - 11/3
2.5	Interstate 40	NC 42	US 70	7-Day	10/18 - 10/24
Screenline 3: South of Raleigh, West of NC 50					
3.1	Timber Dr.	Thompson Rd.	Buckingham Rd.	3-Day	11/1 - 11/3
3.2	Buffalo Rd.	Misty Meadow Ln.	Shore Dr.	3-Day	11/1 - 11/3
3.3	Ten Ten Rd.	Holland Church Rd.	Rand Rd.	3-Day	11/1 - 11/3
3.4	Pagan Rd.	Rock Service Station Rd.	Holland Church Rd.	3-Day	11/1 - 11/3
3.5	Rock Service Station Rd.	Barber Bridge Rd.	Tyler Farms Dr.	3-Day	11/15 - 11/17
3.6	NC 42	Kay Falls Ln.	Jays Bridge Dr.	7-Day	10/21 - 10/27
Screenline 4: South of Raleigh, East of US 401					
4.1	US 401	Simpkins Rd.	Woodcrest Dr.	7-Day	10/21 - 10/27
4.2	Ten Ten Rd.	Old McCullers Rd. (NC 2722)	Fanny Brown Rd. (NC 2723)	3-Day	11/1 - 11/3
4.3	Banks Rd.	Chelsea Dr.	Fanny Brown Rd. (NC 2723)	3-Day	11/1 - 11/3
Screenline 5: Southwest of Raleigh, East of Holly Springs Road					
5.1	Penny Rd.	Heather Stone Dr.	Sparrow Pond Ln.	3-Day	10/25 - 10/27
5.2	Ten-Ten Rd.	Lawdraker Rd.	West Lake Rd.	3-Day	10/25 - 10/27
5.3	Optimist Farm Rd.	Talcut Trail	Glade Hill Dr.	3-Day	10/25 - 10/27
5.4	Hilltop Needmore Rd.	Autumn Creek Dr.	Old Mills Rd.	3-Day	10/25 - 10/27
Screenline 6: West of Raleigh, North of Highhouse Road					
6.1	Davis Dr.	Council Gap Court	Carramore Ave.	3-Day	10/25 - 10/27
6.2	Louis Stephenson Dr.	Carpenter Upchurch Rd.	Carramore Ave.	3-Day	11/1 - 11/3
6.3	NC 55	Highfield Ave.	Wellesley Trade Ln.	7-Day	01/13 - 01/19
6.4	Green Level Church Rd.	Southerlyn Ln.	Beaver Dam Rd.	3-Day	11/1 - 11/3
6.5	White Oak Church Rd.	Pine Rail Ln.	Morrisville Parkway	3-Day	11/1 - 11/3
6.6	Green Level Rd.	Luther Rd.	Verde Rd.	3-Day	11/1 - 11/3
6.7	NC 751	Caley Wilson Rd.	Lexington Dr.	3-Day	11/1 - 11/3

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Table 2.7 (Continued)
Traffic Count Locations and Collection Dates (1)

Location #	Count Location	Data Collected Between These Crossroads		Count Duration	Collection Dates in 2016
		Crossroad 1	Crossroad 2		
Screenline 7: West of Raleigh, South of Interstate 40					
7.1	NC 55 (Apex Highway)	Kit Creek Rd.	Green Level Church Rd.	7-Day	10/20 - 10/26
7.2	Louis Stephens Dr.	Kit Creek Rd.	Development Dr.	3-Day	10/18 - 10/20
7.3	Davis Dr.	Wally Gilbert Dr.	Development Dr.	3-Day	10/18 - 10/20
7.4	NC 54	Surles Ct.	Emperor Blvd.	7-Day	10/21 - 10/27
7.5	Airport Blvd.	Perimeter Park Dr.	Factory Shops Rd.	3-Day	10/18 - 10/20
Screenline 8: Circumferential Locations Adjacent to Complete 540 Route					
8.1	Hopson Rd.	Lewis Stephenson Dr.	NC 147	3-Day	10/18 - 10/20
8.2	Davis Dr.	Select Dr.	Merrion Ave.	3-Day	10/18 - 10/20
8.3	NC 54	Davis Dr.	New Millenium Way	3-Day	10/18 - 10/20
8.4	NC 55	McCrimmon Parkway	Triangle Expressway	3-Day	10/18 - 10/20
8.5	Green Hope School Rd.	Brooks Park Ln.	Twyla Rd.	3-Day	11/1 - 11/3
8.6	Green Level West Rd.	KC Farm Rd.	Spring Green Rd.	3-Day	11/1 - 11/3
8.7	Green Level West Rd.	Triangle Expressway	Branton Dr.	3-Day	01/24 - 01/26
8.8	US 64	Jenks Rd.	Triangle Expressway	3-Day	10/25 - 10/27
8.9	US 64	NC 55	Davis Dr. /N. Salem St.	7-Day	10/20 - 10/26
8.10	Olive Chapel Rd.	Piney Woods Ln.	Apex Barbecue Rd.	3-Day	10/25 - 10/27
8.11	Old US Highway 1	Triangle Expressway	Apex Barbecue Rd.	3-Day	10/25 - 10/27
8.12	NC 55	Triangle Expressway	E. William St.	7-Day	10/20 - 10/26
8.13	Holly Springs Rd.	Lockley Rd.	Fairview St.	3-Day	01/24 - 01/26
8.14	West Lake Rd.	Langston Circle	Lorbacher Rd.	3-Day	10/25 - 10/27
8.15	Bells Lake Rd.	Oxford Green Dr.	Bells Pointe Court	3-Day	10/25 - 10/27
8.16	Johnson Pond Rd.	Heavy Weight Dr.	Ten Ten Rd.	3-Day	10/25 - 10/27
8.17	Lake Wheeler Rd.	Sugg Farm Ln.	Ridgebrook Bluffs Dr.	3-Day	10/25 - 10/27
8.18	US 401	NC 2779/Donny Brook Rd.	Allen St. West	7-Day	10/21 - 10/27
8.19	Fanny Brown Rd.	Laneridge Court (NC 2723)	Ten-Ten Rd.	3-Day	11/1 - 11/3
8.20	Old Stage Rd.	Rolling Meadows Dr.	Rolling Farm Dr.	3-Day	11/1 - 11/3
8.21	Sauls Rd.	Community Garden Rd.	Ten-Ten Rd.	3-Day	11/1 - 11/3
8.22	Jordan Rd.	Stancil Farm Rd.	Guffy Dr.	3-Day	11/1 - 11/3
8.23	NC 50	Seven Oaks Dr.	Grissom Farm Rd.	7-Day	10/21 - 10/27
8.24	White Oak Rd.	Hayward Court	Escondido Farm Rd.	3-Day	11/1 - 11/3
8.25	Rock Quarry Rd.	Old Baucom Rd.	Auburn Knightdale Rd.	3-Day	11/1 - 11/3
8.26	Poole Rd (NC 2555)	Southbridge Rd.	Grasshopper Rd.	3-Day	11/15 - 11/17
8.27	Interstate 40	Rock Quarry Rd (Exit 300)	Hammond Rd. (Exit 299)	7-Day	11/28 - 12/04
8.28	Interstate 40	Gorman St (Exit 295)	US 64/US 1 (Exit 293)	3-Day	11/01 - 11/03
8.29	Interstate 40	N. Harrison Ave (Exit 287)	Aviation Pkwy (Exit 285)	3-Day	11/01 - 11/03

1) The traffic counts were conducted by The Traffic Group.

Table 2.8
Summary of Weekday and Weekend Day Traffic Volumes at Count Locations
Based on Traffic Counts Conducted in the Fall of 2016

<u>Location #</u>	<u>Count Location</u>	<u>Average Weekday Traffic (1)</u>	<u>Average Weekend Day Traffic (2)</u>	<u>Percent Trucks Weekday (3)</u>	<u>Percent Trucks Weekend Day (3)</u>
Screenline 1: East Side of Raleigh, South of Pool Road					
1.1	S. New Hope Rd.	17,400	--	2.7%	--
1.2	Barwell Rd.	6,000	--	0.5%	--
1.3	Auburn Knightdale Rd.	2,900	--	2.3%	--
1.4	Mial Plantation Rd.	4,600	--	1.1%	--
Screenline 2: East side of Raleigh, South of Business 70					
2.1	White Oak Rd. (NC 2547)	14,400	--	1.0%	--
2.2	Interstate 40	90,100	88,100	12.5%	5.8%
2.3	Raynor Rd. (NC 2555)	4,900	--	1.1%	--
2.4	Guy Rd (NC 2558)	7,600	--	0.8%	--
2.5	Interstate 40	67,000	64,900	14.5%	8.0%
Screenline 3: South of Raleigh, West of NC 50					
3.1	Timber Dr.	18,400	--	0.4%	--
3.2	Buffalo Rd.	2,900	--	0.1%	--
3.3	Ten Ten Rd.	13,100	--	1.5%	--
3.4	Pagan Rd.	1,700	--	0.3%	--
3.5	Rock Service Station Rd.	4,100	--	7.2%	--
3.6	NC 42	10,400	8,800	2.9%	1.5%
Screenline 4: South of Raleigh, East of US 401					
4.1	US 401	36,500	24,300	2.2%	0.9%
4.2	Ten Ten Rd.	17,900	--	1.4%	--
4.3	Banks Rd.	6,600	--	1.1%	--
Screenline 5: Southwest of Raleigh, East of Holly Springs Road					
5.1	Penny Rd.	9,800	--	0.6%	--
5.2	Ten-Ten Rd.	19,400	--	1.7%	--
5.3	Optimist Farm Rd.	9,600	--	0.3%	--
5.4	Hilltop Needmore Rd.	9,300	--	2.0%	--
Screenline 6: West of Raleigh, North of High House Road					
6.1	Davis Dr.	30,600	--	1.0%	--
6.2	Louis Stephenson Dr.	3,400	--	0.0%	--
6.3	NC 55	31,400	24,800	19.8%	13.0%
6.4	Green Level Church Rd.	8,900	--	0.8%	--
6.5	White Oak Church Rd.	700	--	0.1%	--
6.6	Green Level Rd.	1,200	--	1.6%	--
6.7	NC 751	7,600	--	2.5%	--

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Table 2.8 (Continued)
Summary of Weekday and Weekend Day Traffic Volumes at Count Locations
Based on Traffic Counts Conducted in the Fall of 2016

<u>Location #</u>	<u>Count Location</u>	<u>Average Weekday Traffic (1)</u>	<u>Average Weekend Day Traffic (2)</u>	<u>Percent Trucks Weekday (3)</u>	<u>Percent Trucks Weekend Day (3)</u>
Screenline 7: West of Raleigh, South of Interstate 40					
7.1	NC 55 (Apex Highway)	24,100	15,000	1.3%	0.6%
7.2	Louis Stephens Dr.	5,400	--	0.1%	--
7.3	Davis Dr.	23,500	--	0.7%	--
7.4	NC 54	23,000	11,900	1.2%	0.7%
7.5	Airport Blvd.	24,200	--	2.6%	--
Screenline 8: Circumferential Locations Adjacent to Complete 540 Route					
8.1	Hopson Rd.	10,600	--	0.4%	--
8.2	Davis Dr.	20,500	--	0.8%	--
8.3	NC 54	12,100	--	0.4%	--
8.4	NC 55	34,500	--	1.9%	--
8.5	Green Hope School Rd.	5,700	--	1.0%	--
8.6	Green Level West Rd.	6,500	--	1.9%	--
8.7	Green Level West Rd.	10,000	--	1.3%	--
8.8	US 64	27,100	--	6.3%	--
8.9	US 64	46,500	37,700	2.5%	1.0%
8.10	Olive Chapel Rd.	5,000	--	2.1%	--
8.11	Old US Highway 1	7,400	--	5.2%	--
8.12	NC 55	31,000	24,400	3.5%	1.3%
8.13	Holly Springs Rd.	20,800	--	0.4%	--
8.14	West Lake Rd.	8,600	--	0.8%	--
8.15	Bells Lake Rd.	5,800	--	0.5%	--
8.16	Johnson Pond Rd.	4,000	--	0.7%	--
8.17	Lake Wheeler Rd.	7,700	--	0.7%	--
8.18	US 401	26,000	14,400	1.6%	0.8%
8.19	Fanny Brown Rd.	4,700	--	0.3%	--
8.20	Old Stage Rd.	9,800	--	1.0%	--
8.21	Sauls Rd.	4,500	--	0.9%	--
8.22	Jordan Rd.	2,000	--	0.2%	--
8.23	NC 50	16,200	14,700	1.2%	0.7%
8.24	White Oak Rd.	11,100	--	0.6%	--
8.25	Rock Quarry Rd.	5,200	--	1.8%	--
8.26	Poole Rd (NC 2555)	9,900	--	1.4%	--
8.27	Interstate 40	107,100	72,900	8.5%	2.6%
8.28	Interstate 40	125,000	--	11.6%	--
8.29	Interstate 40	185,600	--	13.3%	--

1) Represents the average of Tuesday, Wednesday and Thursday traffic count volumes.

2) Represents the average of Saturday and Sunday traffic count volumes.

3) Trucks are defined as vehicles with three or more axles.

2.2.2 2016 Average Weekday Traffic Volumes in the Study Area

Figure 2.3 illustrates 2016 average weekday traffic volumes at many locations in the study area. Included are traffic volumes along the CDM Smith screenline locations, and at other select locations on the Triangle Expressway and other area roads. The counts collected by The Traffic Group, in combination with average annual daily traffic (AADT) data and average annual weekday traffic (AAWDT) data from the NCDOT and NCTA, were used to calibrate the TRM to 2016 conditions at select roads in the study area.

2.2.3 Hourly 2016 Traffic Variations

This section provides a sample of average weekday (Tuesday through Thursday) hourly traffic variations and directional patterns at count locations on screenlines 2, 5 and 7. **Figure 2.4** presents hourly variations at the four count locations along screenline 2. All four locations display a distinct AM peak in the northbound direction, and a reciprocal PM peak in the southbound direction. **Figure 2.5** presents hourly variations at four locations on screenline 5. Traffic across screenline 5 generally peaks in the westbound direction during AM commuting hours, and in the eastbound direction during PM commuting hours. **Figure 2.6** presents hourly variations at four locations on screenline 7. Counts at all 4 locations display a distinct AM peak in the northbound direction toward Triangle Research Park and I-40, and a reciprocal PM peak in the southbound direction. Detailed information on average weekday traffic volumes by time period is available for all count locations conducted by The Traffic Group in the CDM Smith Technical Memorandum *Complete 540 Planning Study – Data Collection*, dated February 3, 2017.

2.3 INRIX/HERE Time Speed Data

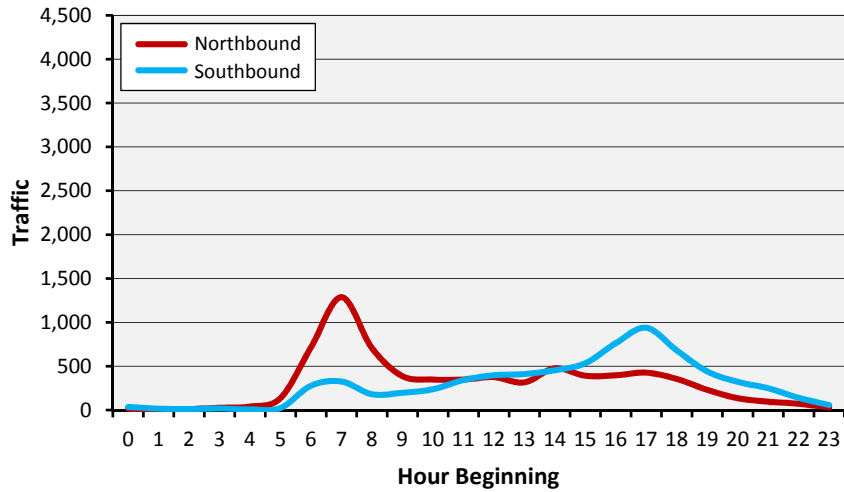
Travel speed data was obtained from both INRIX and HERE via Regional Integrated Transportation Information System (RITIS) with permission from NCDOT. Travel speed data was collected for the 12-month period from October 2015 through September 2016. NCDOT utilized INRIX until the end of calendar year 2015 and switched to HERE in January 2016. Both vendors provide travel speeds and distance by roadway segment based on GPS data, from which travel time can be calculated. CDM Smith reviewed North Carolina-specific data validation reports produced for the I-95 Corridor Coalition for INRIX and HERE. Based on that review, and prior experience using and validating INRIX data, CDM Smith found both INRIX and HERE acceptable indicators of current travel speeds for this study.

INRIX/HERE have recent travel speed data for many roads in the Raleigh area as shown in **Figure 2.7**. CDM Smith compiled and summarized travel speeds for selected road segments in the study area, and used that information to calculate travel times. **Figure 2.8** shows free-flow travel times by segment and direction for a sampling of the selected routes. It should be noted that minor differences in free-flow travel time by direction on a given segment can be attributed to directional variances in the distances provided by HERE/INRIX. For comparison purposes, **Figure 2.9** and **Figure 2.10** show travel times by segment and direction for the same routes during the AM peak hour (7-8 AM) and the PM peak hour (5-6 PM). For example, northbound travel times on NC 55 near the Triangle Expressway averaged 32.9 minutes under free-flow conditions, 39.7 minutes during the AM peak hour, and 46.7 minutes during the PM peak hour.

The travel times in Figures 2.8 through 2.10 are high-level summaries. For use in calibrating to 2016, travel times were available in smaller segments.

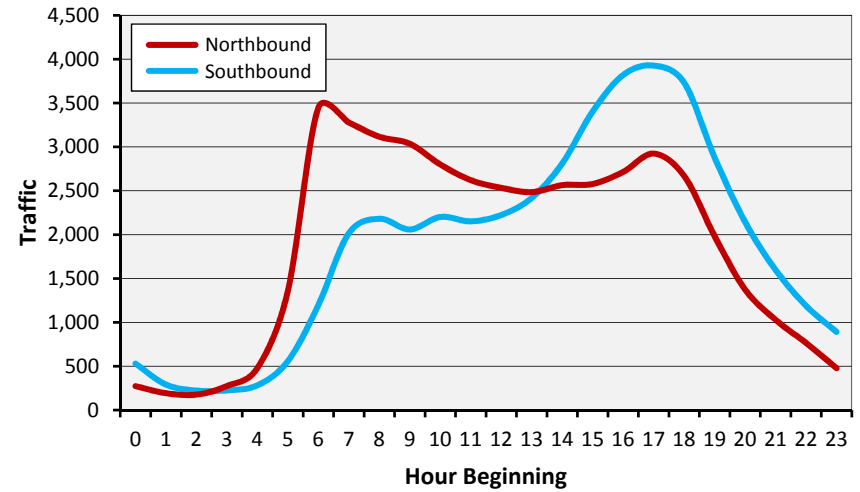
Location 2.1

White Oak Road Between Ackerman Road and Bryan Road



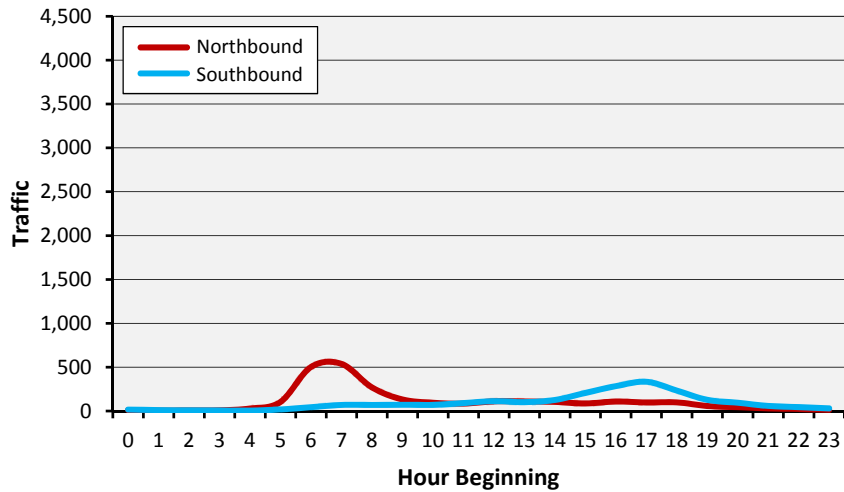
Location 2.2

I-40 Between Business 70 and US 70 (Clayton Bypass)



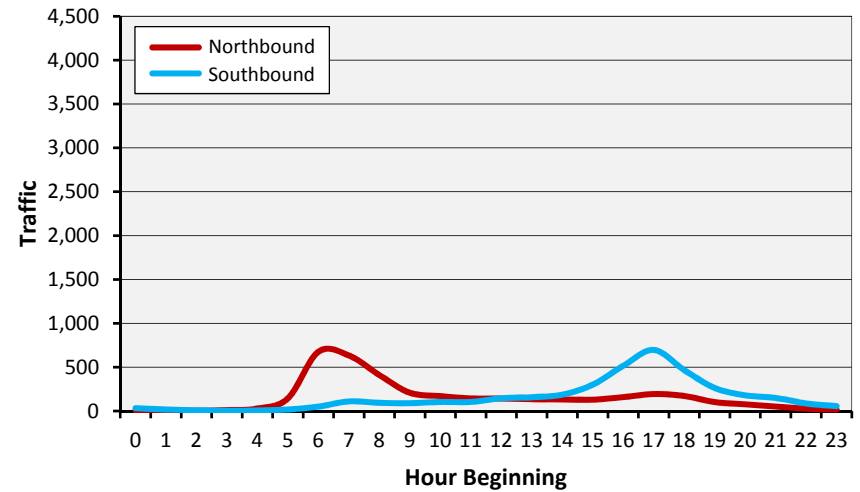
Location 2.3

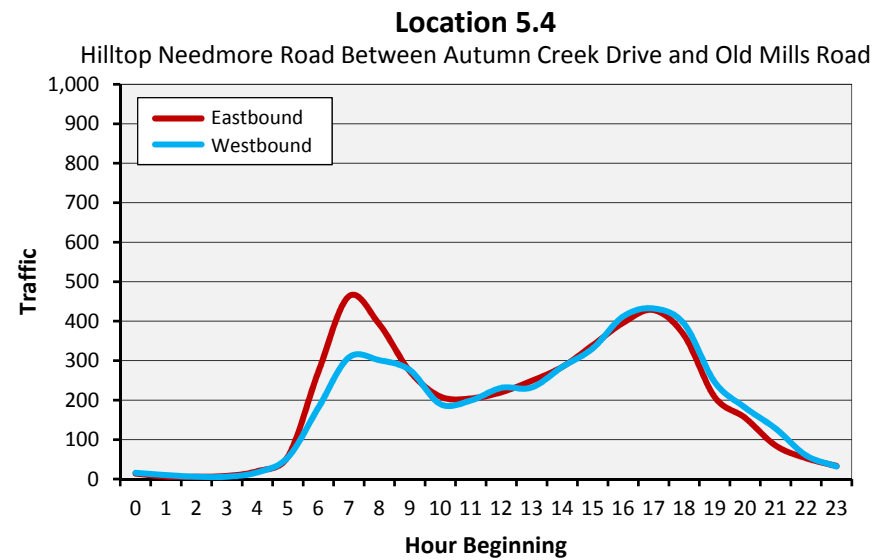
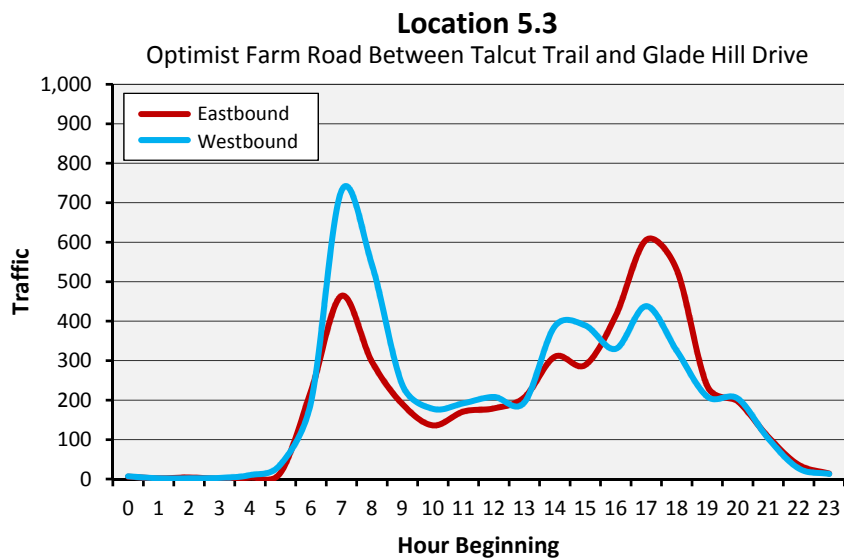
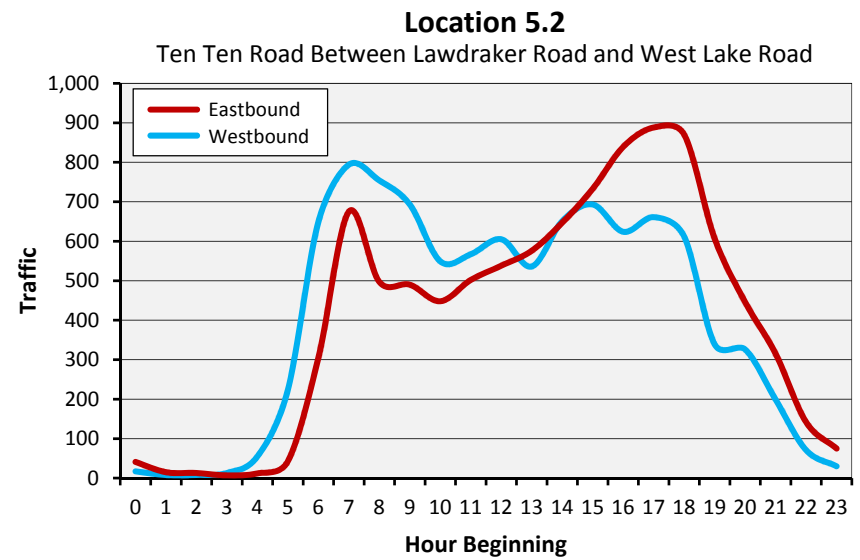
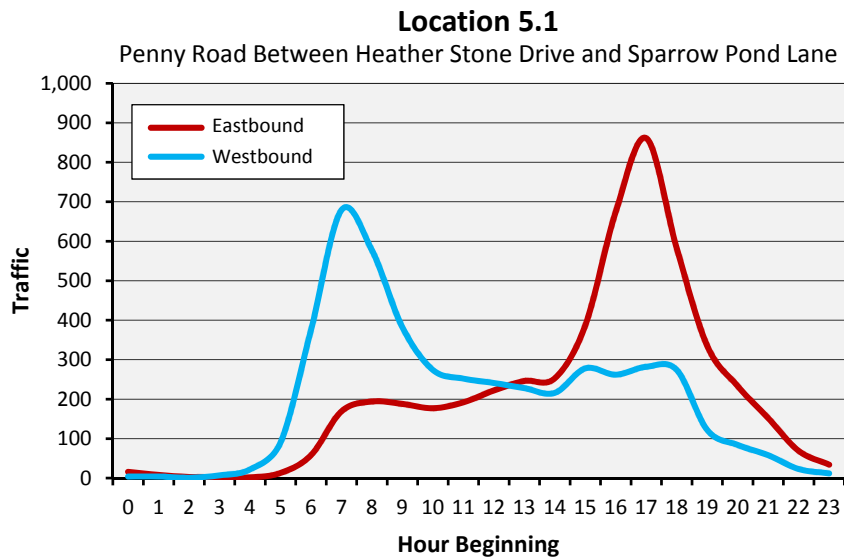
Raynor Road Between White Oak Road and Twain Drive

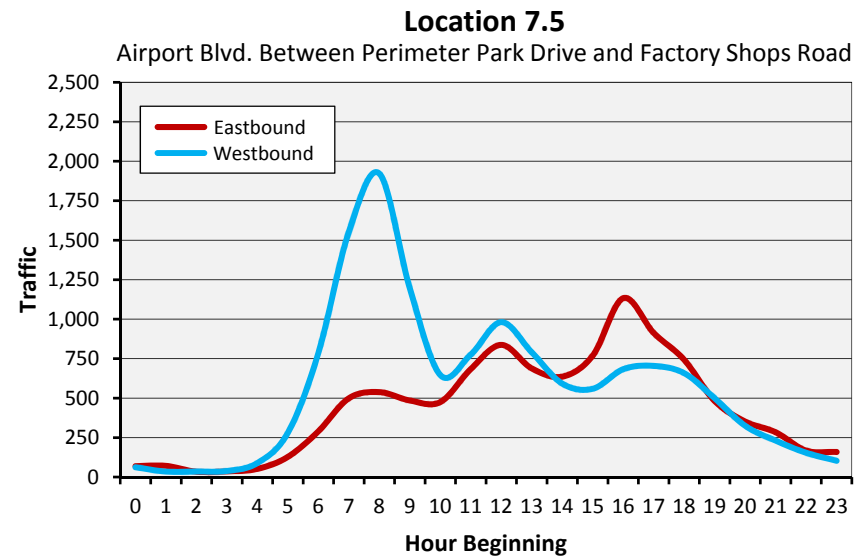
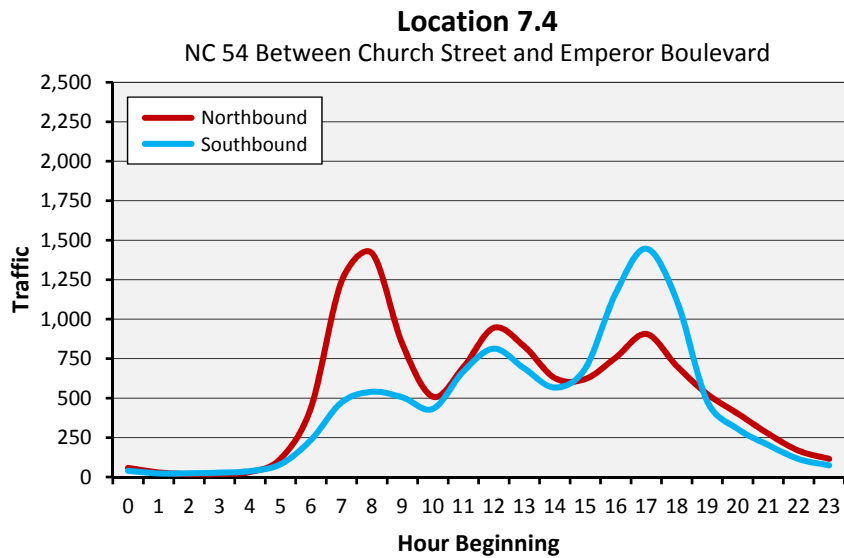
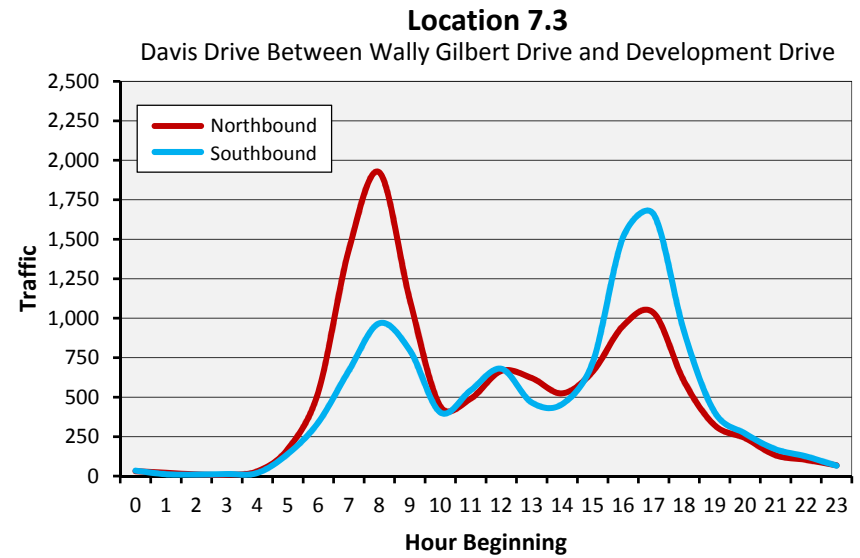
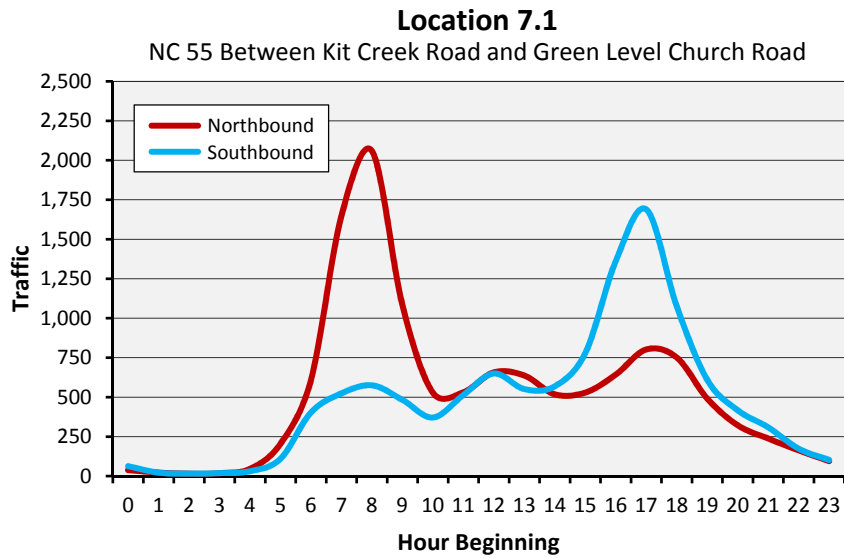


Location 2.4

Guy Road Between White Oak Circle and Golden Nugget Drive

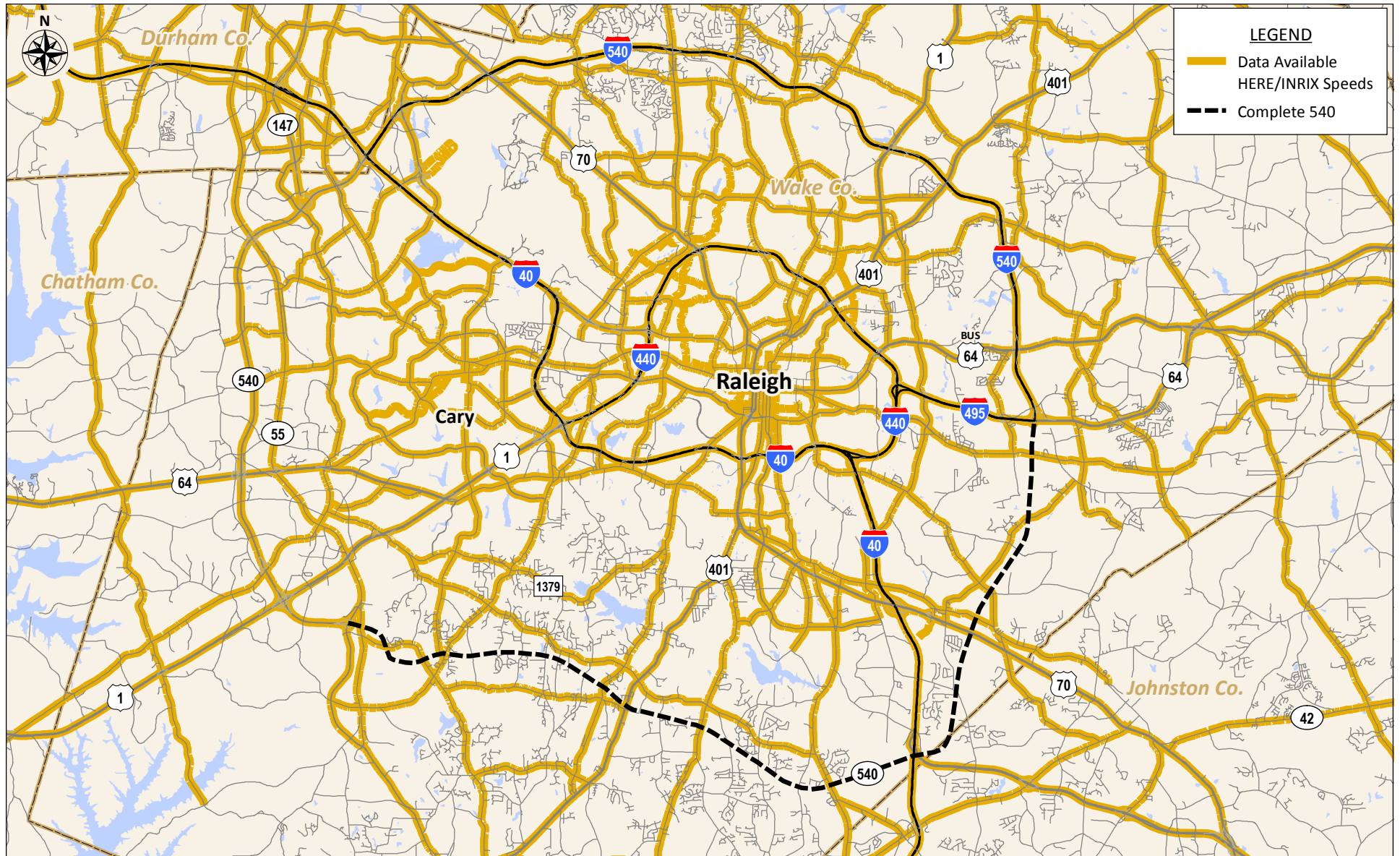






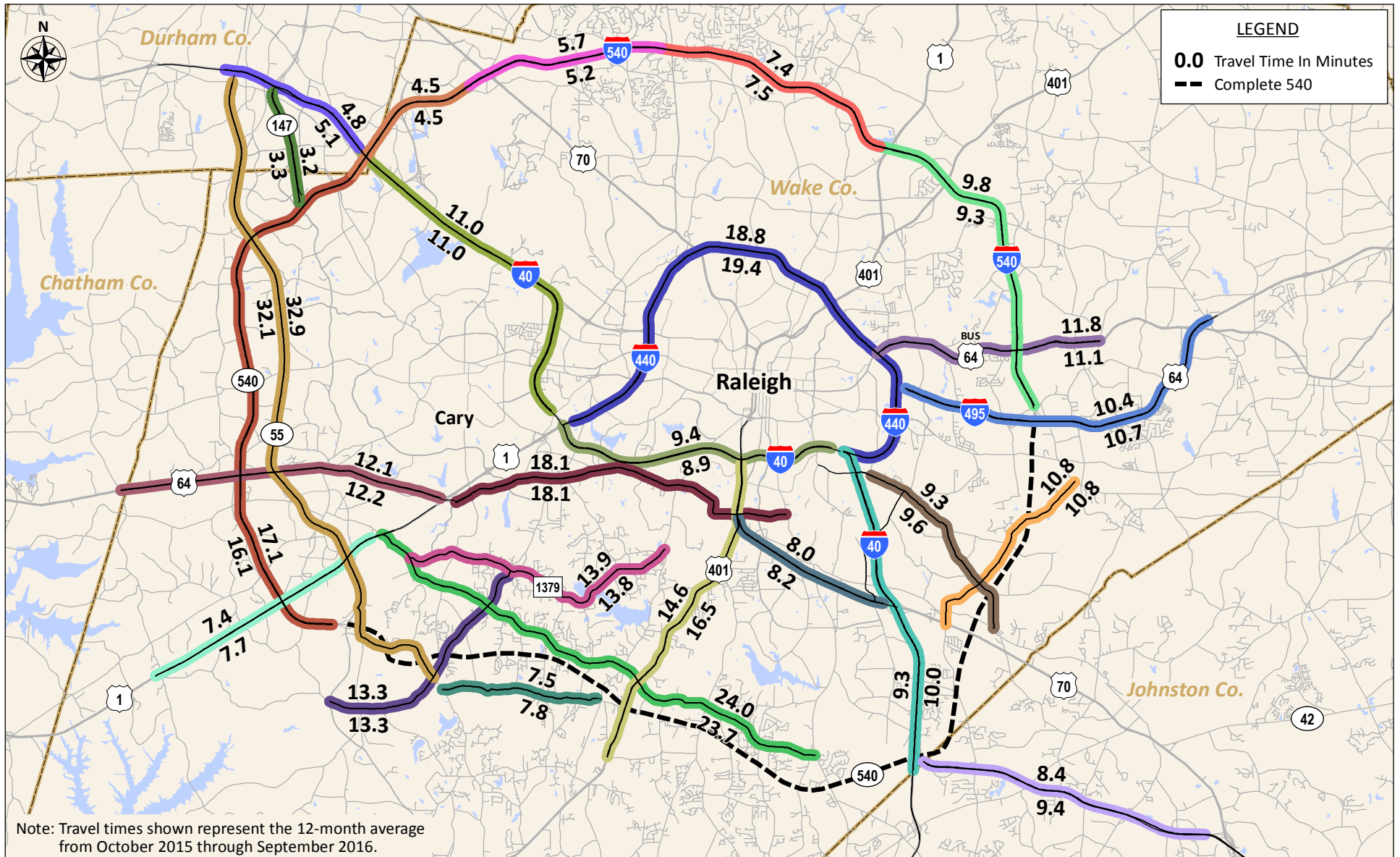
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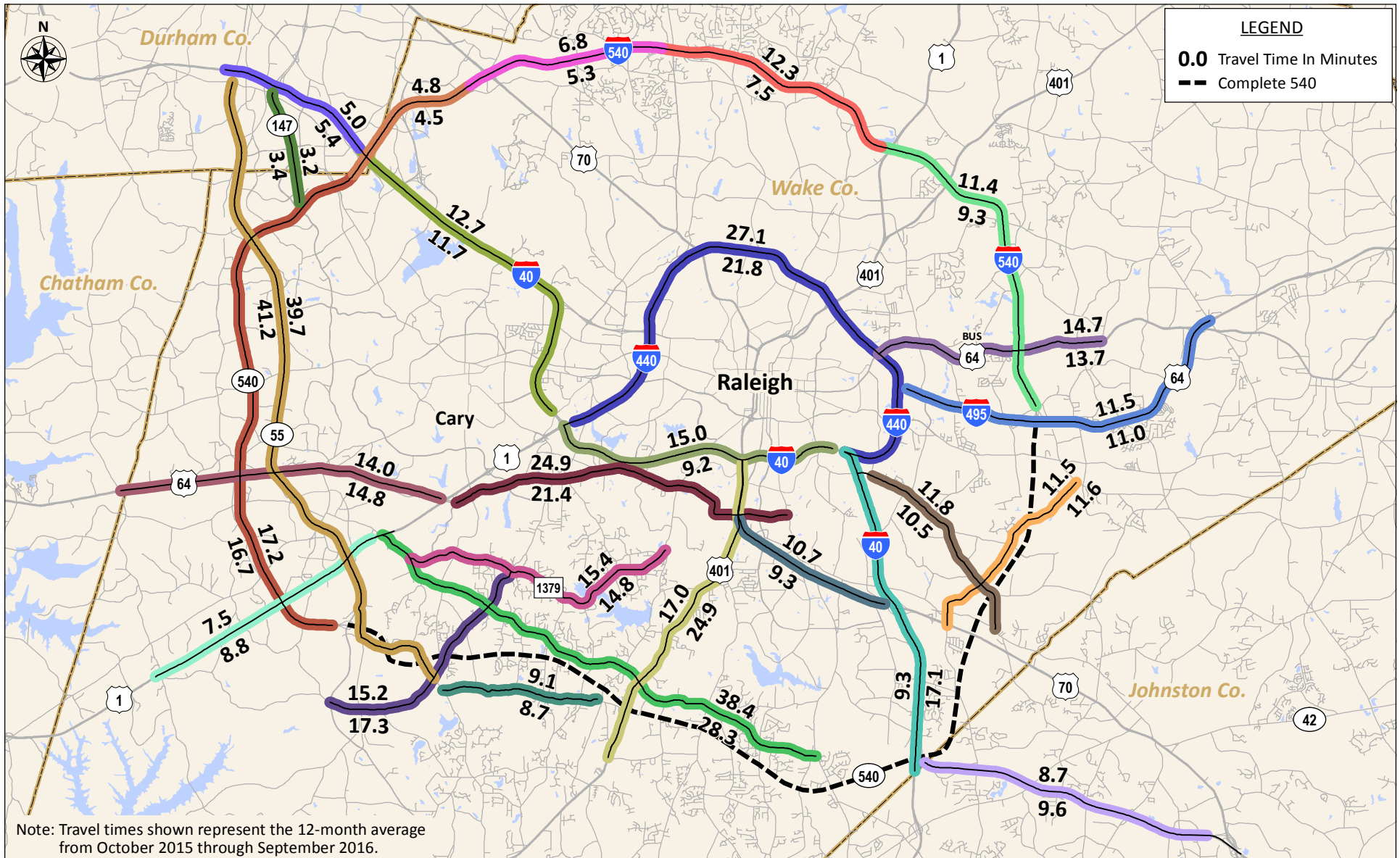
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Complete 540 Planning Level Traffic and Revenue Study

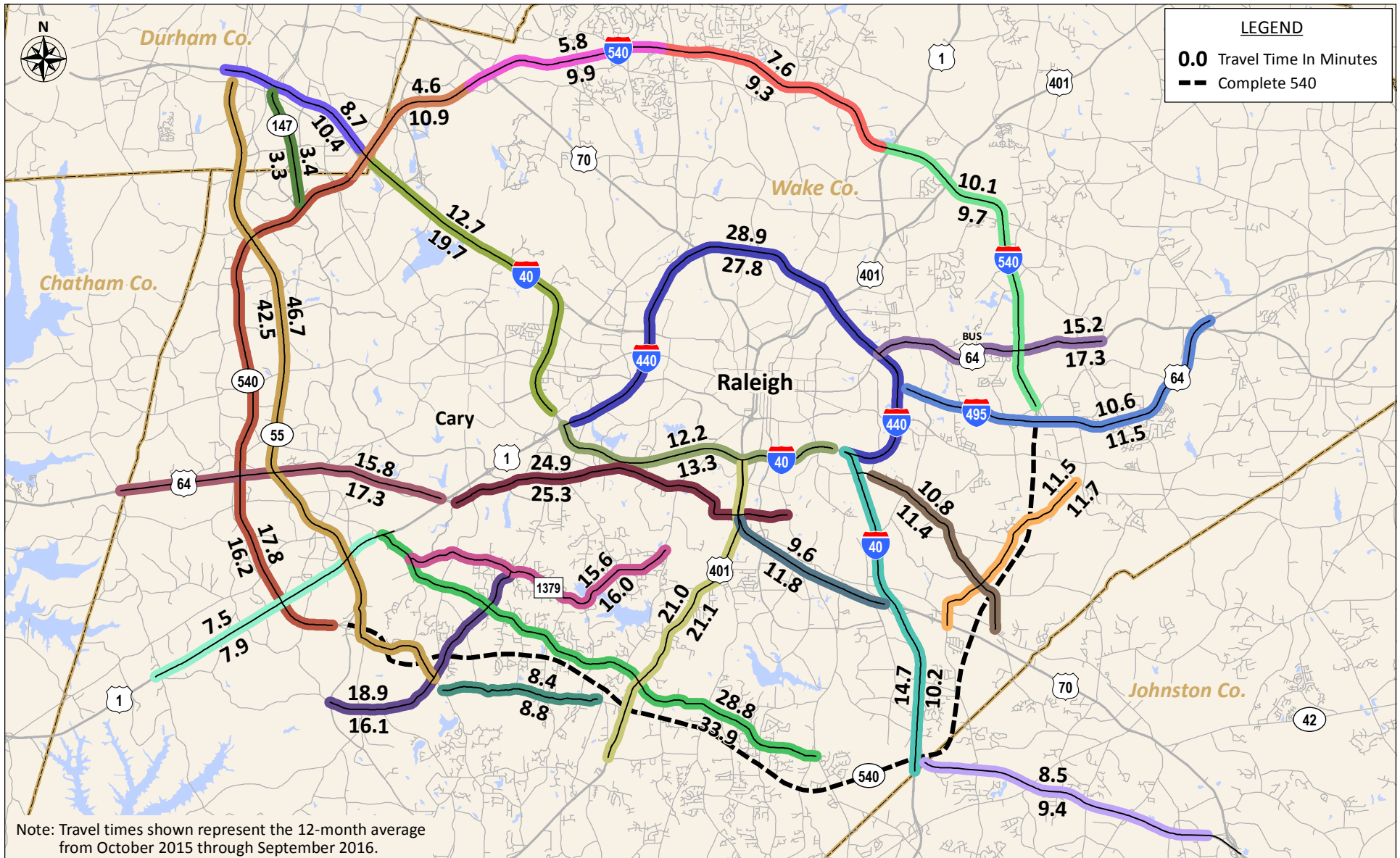
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**AM WEEKDAY PEAK-HOUR TRAVEL TIMES
7:00 AM - 8:00 AM**

Complete 540 Planning Level Traffic and Revenue Study

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**PM WEEKDAY PEAK-HOUR TRAVEL TIMES
5:00 PM - 6:00 PM**

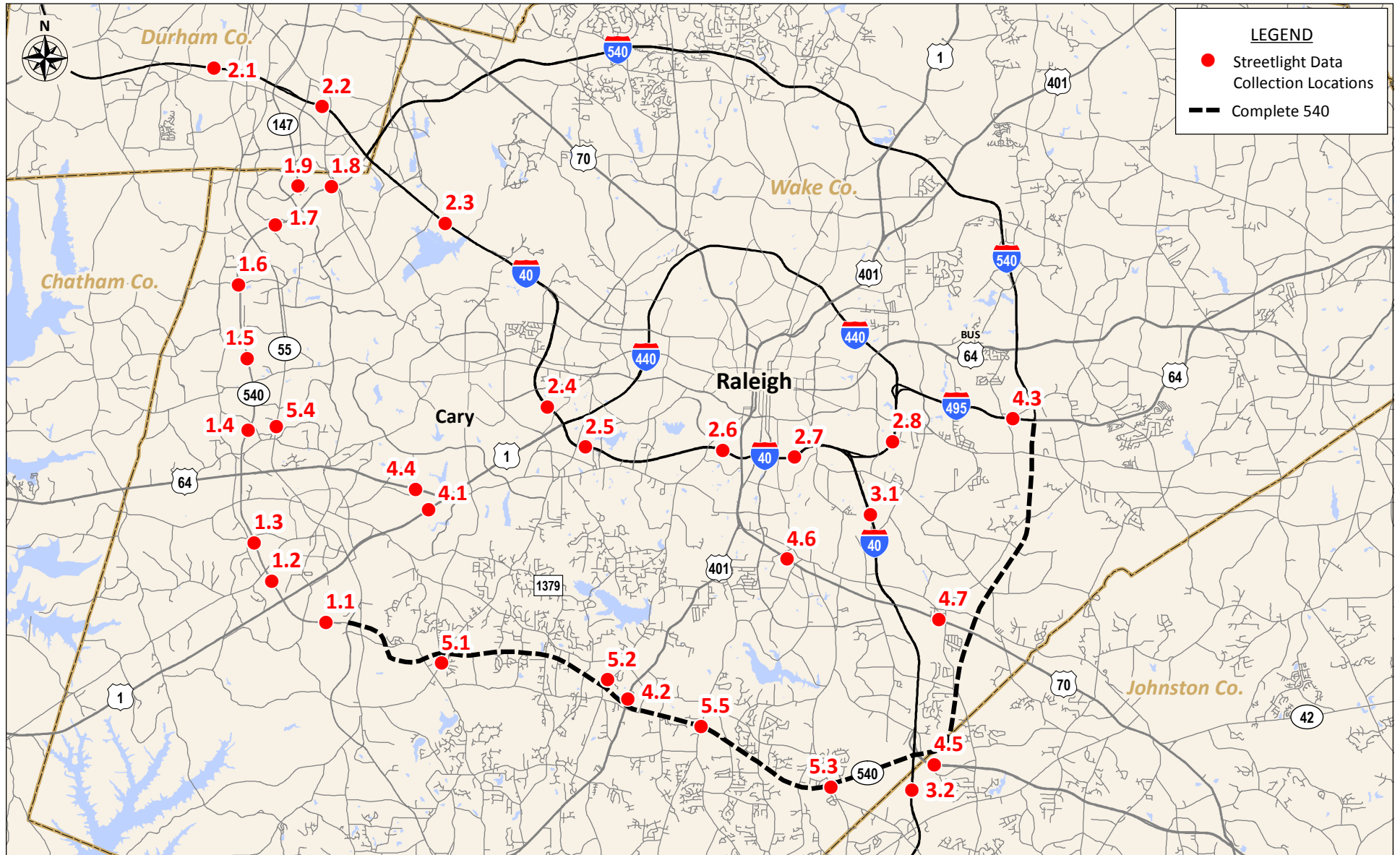
2.4 Origin-Destination Data

One full year of recent origin-destination data was obtained from StreetLight Data, Inc. The data provides insight into travel patterns and distances travelled, by time period, for movements crossing 30 data collection points located on I-40, the Triangle Expressway, and various other roads in the study area. The location of the 31 StreetLight data collection points can be seen in **Figure 2.11**. A description of the 31 data collection points is presented in **Table 2.9**.

This data is similar to data obtained from license plate surveys. It is not true origin-destination data but can provide indications of trip distances and travel patterns on select roads. The data points were selected to obtain trip distance information on the Triangle Expressway and I-40. It was also designed to determine whether vehicles observed on roads intersecting the proposed 540 were also seen on I-40, U.S. 1, US 70, or the Triangle Expressway.

The origin-destination data was used in validating select travel patterns and trip distances in the TRM, and in providing a better understanding of the current travel patterns on the Triangle Expressway. The uses of the StreetLight data will be discussed in more detail in Chapter 3, Section 3.6.

Location #	Direction	Roadway	Data Collected Between These Crossroads	
			Crossroad 1	Crossroad 2
Corridor 1: Triangle Expressway				
1.1	NB / SB	Toll 540	US 1	NC 55 Bypass
1.2	NB / SB	Toll 540	Old US Hwy 1	US 1
1.3	NB / SB	Toll 540	US Hwy 64	Old US Hwy 1
1.4	NB / SB	Toll 540	Green Level Rd. W	US Hwy 64
1.5	NB / SB	Toll 540	Green Hope School Rd.	Green Level Rd. W
1.6	NB / SB	Toll 540	NC 55	Green Hope School Rd.
1.7	NB / SB	Toll 540	NC 147 Triangle Expressway	NC 55
1.8	NB / SB	Toll 540	NC 54	NC 147 Triangle Expressway
1.9	NB / SB	NC 147	Davis Dr.	I-540
Corridor 2: I-40 / I-440				
2.1	EB / WB	I-40	NC 54	NC 55
2.2	EB / WB	I-40	Davis Dr.	S Miami Blvd.
2.3	EB / WB	I-40	Aviation Parkway	N Harrison Ave.
2.4	EB / WB	I-40	Cary Towne Blvd.	US-1 / I-440
2.5	EB / WB	I-40	US-1 / I-440	Gorman St.
2.6	EB / WB	I-40	Lake Wheeler Rd.	US-401 / S Saunders St.
2.7	EB / WB	I-40	Hammond Rd.	Rock Quarry Rd.
2.8	EB / WB	I-440	Poole Rd.	I-40
3.1	NB / SB	I-40	Jones Sausage Rd.	I-440
3.2	NB / SB	I-40	NC 42	US 70 Clayton Bypass
Selected Bi-Directional Locations				
4.1	EB / WB	US 1	Ten-Ten Rd.	US-64
4.2	NB / SB	US 401	Donny Brook Rd.	Ten-Ten Rd.
4.3	EB / WB	US 64 Bypass	Hodge Rd.	I-540
4.4	EB / WB	US 64	Lake Pine Dr.	US-1
4.5	EB / WB	US 70 Clayton Bypass	I-40	Cornwallis Rd.
4.6	EB / WB	US 70	Yeargan Rd.	Vandora Springs Rd.
4.7	EB / WB	US 70	I-40 / US 70	Auburn-Knightdale Rd.
Selected Combined Direction Locations				
5.1	NB + SB	Holly Springs Rd.	Sunset Lake Rd.	Kildaire Farm
5.2	NB + SB	Lake Wheeler Rd.	Optimist Farm Rd.	Ten-Ten Rd.
5.3	NB + SB	NC 50	Cleveland School Rd.	Ten-Ten Rd.
5.4	NB + SB	NC 55	Jenks Rd.	Green Level Rd. W
5.5	NB + SB	Old Stage Rd.	Banks Rd.	Ten-Ten Rd.



Chapter 3

Model Review, Refinement and Calibration

This chapter describes the Triangle Regional Model (TRM) and the review and modifications made to the TRM for use in developing the traffic and toll revenue estimates for this study. The configuration of the Triangle Expressway and Complete 540 and the assumed toll locations on Complete 540 are also presented.

3.1 Regional Traffic Demand Model Description

The Triangle Regional Model version 5 was used for this study. The TRMv5 is the official travel demand model of the Research Triangle region and is used by the Capital Area Metropolitan Planning Organization (CAMPO), the Durham-Chapel Hill-Carrboro Metropolitan Planning Organization (DCHC MPO), the North Carolina Department of Transportation, and Go Triangle. The model is maintained by the Triangle Regional Model Service Bureau, a division of the Institute for Transportation Research and Education (ITRE) of North Carolina State University.

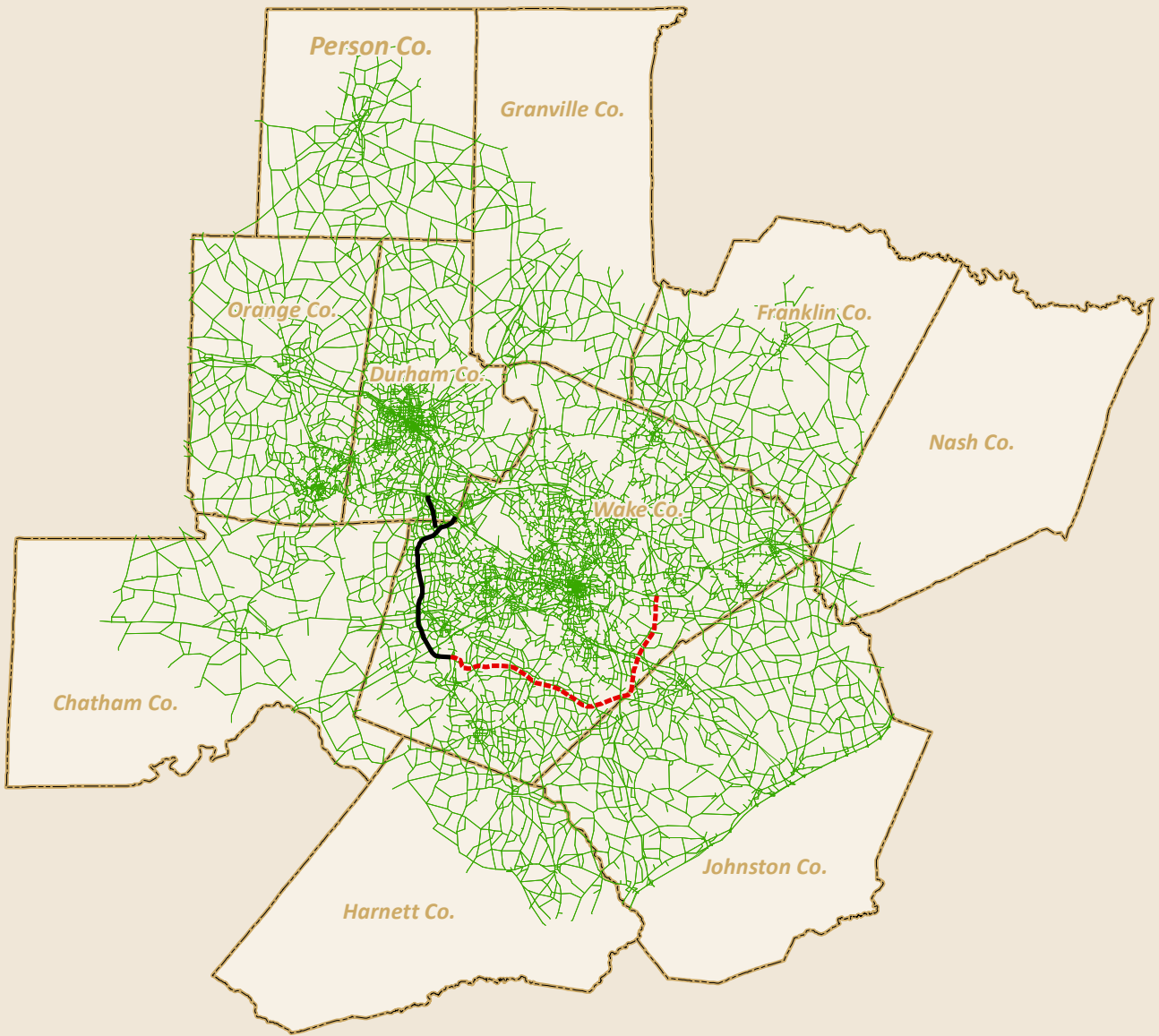
TRMv5 was the currently adopted model at the time of this study. It supports network and trip table years 2010, 2015, 2020, 2030 and 2040. ITRE calibrated the model to 2010 conditions. The model was developed using population and employment data for 2005. The model includes all of Orange, Wake and Durham counties, and parts of Chatham, Person, Granville, Franklin, Nash, Johnston, and Harnett counties. There are 2,579 Traffic Analysis Zones (TAZs) and ninety-nine external stations in the TRMv5. **Figure 3.1** shows the model region, including the highlighted Triangle Expressway and Complete 540 alignment. The Triangle Expressway is located primarily in Wake County and partially in Durham County, and the proposed Complete 540 is located entirely in Wake County.

The TRMv5 provides weekday trip tables in 8 time periods, representing peak period conditions and off-peak conditions. The 8 time periods are defined below:

- AM Peak Period (AM1-AM3)
 - AM1: 6:00 AM–7:30 AM
 - AM2: 7:30 AM–8:30 AM
 - AM3: 8:30 AM-10:00 AM

- PM Peak Period (PM1-PM3)
 - PM1: 3:30 PM–5:00 PM
 - PM2: 5:00 PM–6:00 PM
 - PM3: 6:00 PM-7:30 PM

- Off-Peak Period (OP1 and OP2)
 - OP1: 10:00 AM-3:30 PM
 - OP2: 7:30 PM-6:00 AM



LEGEND

- Network Links
- Triangle Expressway
- - - Proposed Complete 540

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3.2 Model Demographics Summary

CDM Smith reviewed the future-year assumptions in the TRMv5 regarding the number of households and employment levels by TAZ for years 2015, 2020, 2030 and 2040 in the study area. These demographics directly influence the number of trips and the travel patterns in the model and are based on assumed land-uses in the model region. This review was conducted to understand the demographic assumptions in the TRMv5. As this is a planning level study, CDM Smith did not request an independent review of the land-use and demographic assumptions in the model. The traffic and toll revenue forecasts in this study are based on the demographic and economic assumptions in the TRMv5.

Table 3.1 provides a summary of the number of households in geographic units called superzones within the detailed study area for years 2015, 2020, 2030 and 2040. The superzones are aggregations of the smaller TAZs. Table 3.1 also shows the change in the number of households between each year, and the average annual percent change in households between each year.

Figure 3.2 graphically shows the total change in number of households from 2015 to 2040 in the TRMv5. Darker shading indicates higher numbers of added households. The highest levels of growth in households within the study area are forecast to occur along the Triangle Expressway/NC 55 corridor, the Complete 540 corridor, and the I-40 corridor south of the Beltline.

Table 3.2 provides an employment summary by superzone for years 2015, 2020, 2030 and 2040, including the change in the number of households between each year, and the average annual percent change in households between each year. **Figure 3.3** graphically shows the total change in employment from 2015 to 2040 in the TRMv5. The highest levels of growth in employment within the detailed study area are forecast to occur along the Triangle Expressway/NC 55 corridor extending south to Fuquay Varina, and scattered communities to the south and east of Raleigh including Garner and Auburn.

3.3 Future Roadway Improvements

The TRMv5 model contains assumed future-year roadway improvements. The roadway improvement assumptions were reviewed for years 2020, 2030 and 2040 and compared against the following two documents.

1. *Draft NCDOT 2017-2027 STIP* (January 2017)
2. *NC Capital Area Metropolitan Planning Organization (CAMPO) 2040 Metropolitan Transportation Plan* (Amended September 2015)

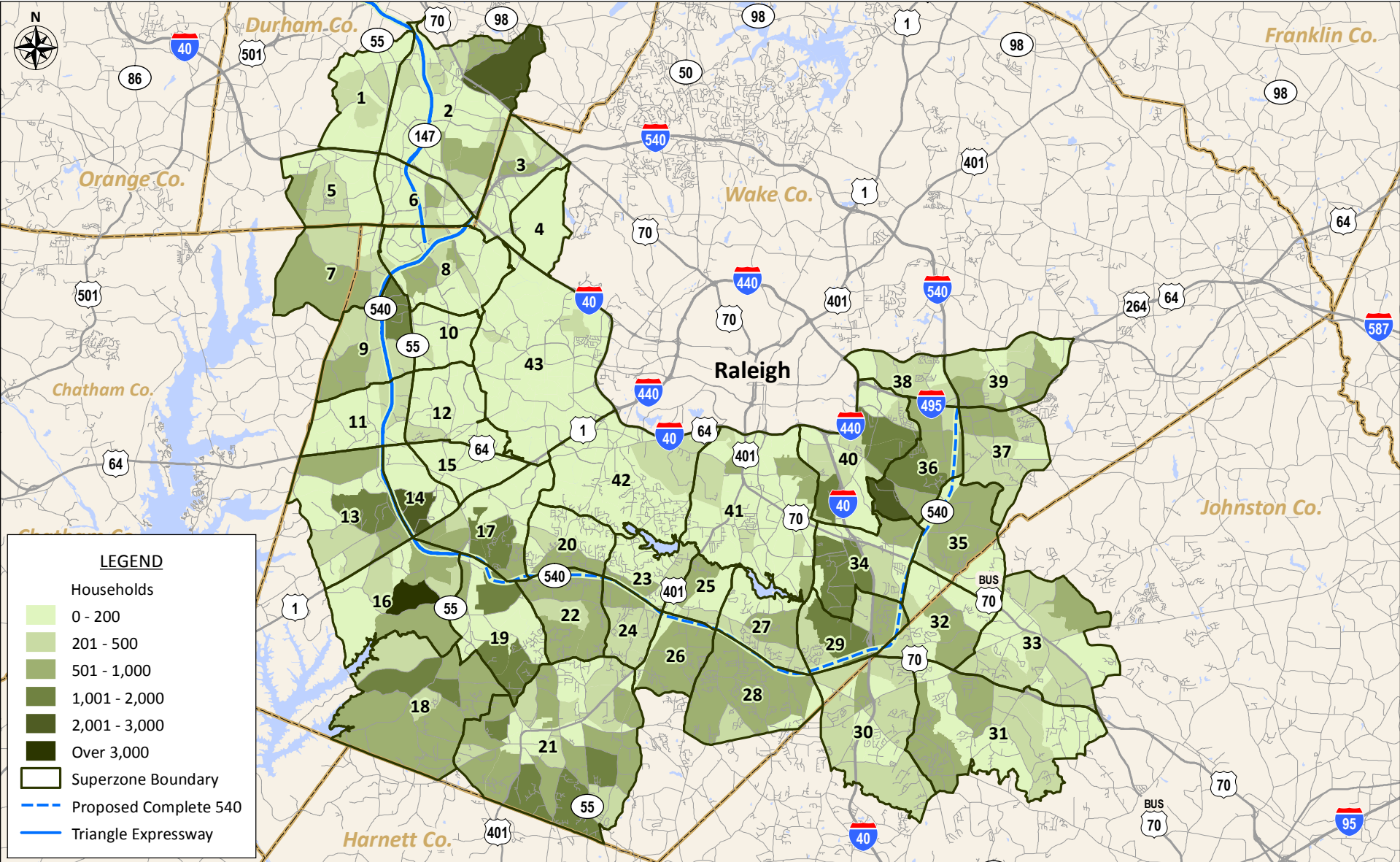
There were several purposes for this review, including:

1. Determine if there were updates to planned road improvements that needed to be reflected in the networks used in this study. The review focused on roadway improvement plans that would add capacity to existing roads, or create a new road in the study area.
2. Determine if the improvement was reflected in the correct model year.

Table 3.1
Total Change in TRMv5 Number of Households

Superzone	TRMv5 Number of Households by Superzone										
	2015	Difference	AAPC (1) 2015-20	2020	Difference	AAPC (1) 2020-30	2030	Difference	AAPC (1) 2030-40	2040	AAPC (1) 2015-40
1	10,587	483	0.9%	11,070	962	0.8%	12,032	963	0.8%	12,995	0.8%
2	7,939	1,446	3.4%	9,385	2,899	2.7%	12,284	2,893	2.1%	15,177	2.6%
3	4,663	357	1.5%	5,020	720	1.3%	5,740	715	1.2%	6,455	1.3%
4	4	0	0.0%	4	0	0.0%	4	0	0.0%	4	0.0%
5	6,848	476	1.4%	7,324	954	1.2%	8,278	954	1.1%	9,232	1.2%
6	1,490	318	3.9%	1,808	634	3.1%	2,442	634	2.3%	3,076	2.9%
7	3,607	532	2.8%	4,139	1,061	2.3%	5,200	1,071	1.9%	6,271	2.2%
8	6,346	735	2.2%	7,081	1,471	1.9%	8,552	1,469	1.6%	10,021	1.8%
9	4,503	745	3.1%	5,248	1,491	2.5%	6,739	1,492	2.0%	8,231	2.4%
10	5,539	120	0.4%	5,659	240	0.4%	5,899	240	0.4%	6,139	0.4%
11	1,793	198	2.1%	1,991	397	1.8%	2,388	393	1.5%	2,781	1.8%
12	8,803	237	0.5%	9,040	477	0.5%	9,517	476	0.5%	9,993	0.5%
13	3,643	812	4.1%	4,455	1,624	3.2%	6,079	1,626	2.4%	7,705	3.0%
14	4,709	627	2.5%	5,336	1,258	2.1%	6,594	1,255	1.8%	7,849	2.1%
15	3,984	96	0.5%	4,080	202	0.5%	4,282	197	0.5%	4,479	0.5%
16	1,643	1,309	12.4%	2,952	2,622	6.6%	5,574	2,621	3.9%	8,195	6.6%
17	5,062	1,023	3.7%	6,085	2,054	3.0%	8,139	2,049	2.3%	10,188	2.8%
18	4,399	1,592	6.4%	5,991	3,190	4.4%	9,181	3,187	3.0%	12,368	4.2%
19	7,909	1,218	2.9%	9,127	2,439	2.4%	11,566	2,440	1.9%	14,006	2.3%
20	2,939	265	1.7%	3,204	531	1.5%	3,735	530	1.3%	4,265	1.5%
21	13,786	3,479	4.6%	17,265	6,961	3.4%	24,226	6,962	2.6%	31,188	3.3%
22	3,525	575	3.1%	4,100	1,151	2.5%	5,251	1,150	2.0%	6,401	2.4%
23	1,429	221	2.9%	1,650	439	2.4%	2,089	441	1.9%	2,530	2.3%
24	2,075	368	3.3%	2,443	737	2.7%	3,180	738	2.1%	3,918	2.6%
25	1,530	236	2.9%	1,766	469	2.4%	2,235	471	1.9%	2,706	2.3%
26	1,658	374	4.2%	2,032	751	3.2%	2,783	751	2.4%	3,534	3.1%
27	2,158	317	2.8%	2,475	631	2.3%	3,106	635	1.9%	3,741	2.2%
28	3,837	728	3.5%	4,565	1,454	2.8%	6,019	1,456	2.2%	7,475	2.7%
29	1,894	545	5.2%	2,439	1,087	3.8%	3,526	1,089	2.7%	4,615	3.6%
30	3,759	640	3.2%	4,399	1,254	2.5%	5,653	1,459	2.3%	7,112	2.6%
31	4,662	521	2.1%	5,183	1,017	1.8%	6,200	1,220	1.8%	7,420	1.9%
32	2,043	457	4.1%	2,500	894	3.1%	3,394	1,038	2.7%	4,432	3.1%
33	6,341	859	2.6%	7,200	1,683	2.1%	8,883	2,013	2.1%	10,896	2.2%
34	3,405	1,108	5.8%	4,513	2,216	4.1%	6,729	2,214	2.9%	8,943	3.9%
35	1,375	426	5.5%	1,801	855	4.0%	2,656	867	2.9%	3,523	3.8%
36	4,860	1,190	4.5%	6,050	2,383	3.4%	8,433	2,380	2.5%	10,813	3.3%
37	2,328	584	4.6%	2,912	1,171	3.4%	4,083	1,170	2.6%	5,253	3.3%
38	3,373	267	1.5%	3,640	535	1.4%	4,175	534	1.2%	4,709	1.3%
39	4,210	890	3.9%	5,100	1,789	3.1%	6,889	1,786	2.3%	8,675	2.9%
40	7,764	1,490	3.6%	9,254	2,981	2.8%	12,235	2,982	2.2%	15,217	2.7%
41	15,422	1,303	1.6%	16,725	2,594	1.5%	19,319	2,606	1.3%	21,925	1.4%
42	11,952	520	0.9%	12,472	1,042	0.8%	13,514	1,044	0.7%	14,558	0.8%
43	27,840	727	0.5%	28,567	1,476	0.5%	30,043	1,470	0.5%	31,513	0.5%
Area Total	227,636	30,414	2.5%	258,050	60,796	2.1%	318,846	61,681	1.8%	380,527	2.1%

(1) AAPC - Average Annual Percent Change

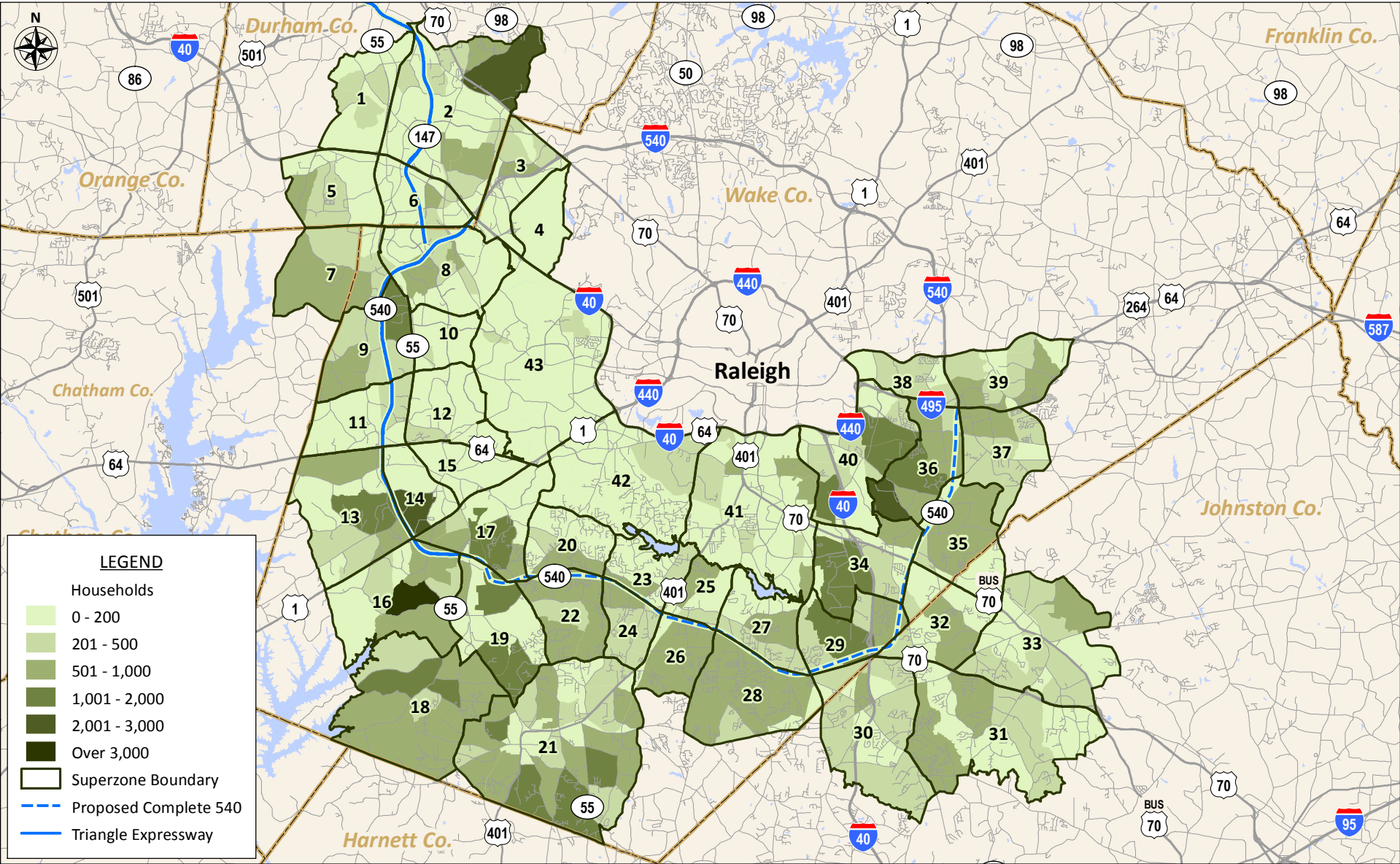


**TOTAL CHANGE IN HOUSEHOLDS
FROM 2015 TO 2040: TRMv5**

Table 3.2
Total Change in TRMv5 Employment

Superzone	TRMv5 Employment by Superzone										
	2015	Difference	AAPC (1) 2015-20	2020	Difference	AAPC (1) 2020-30	2030	Difference	AAPC (1) 2030-40	2040	AAPC (1) 2015-40
1	7,626	581	1.5%	8,207	1,323	1.5%	9,530	1,578	1.5%	11,108	1.5%
2	39,012	4,033	2.0%	43,045	9,226	2.0%	52,271	10,972	1.9%	63,243	2.0%
3	6,059	897	2.8%	6,956	2,006	2.6%	8,962	2,344	2.4%	11,306	2.5%
4	17	19	16.2%	36	42	8.0%	78	48	4.9%	126	8.3%
5	3,081	273	1.7%	3,354	623	1.7%	3,977	737	1.7%	4,714	1.7%
6	22,982	2,115	1.8%	25,097	4,845	1.8%	29,942	5,749	1.8%	35,691	1.8%
7	778	299	6.7%	1,077	680	5.0%	1,757	792	3.8%	2,549	4.9%
8	22,499	2,372	2.0%	24,871	5,305	2.0%	30,176	6,200	1.9%	36,376	1.9%
9	1,449	511	6.2%	1,960	1,149	4.7%	3,109	1,345	3.7%	4,454	4.6%
10	2,364	287	2.3%	2,651	642	2.2%	3,293	749	2.1%	4,042	2.2%
11	1,581	494	5.6%	2,075	1,114	4.4%	3,189	1,296	3.5%	4,485	4.3%
12	4,300	442	2.0%	4,742	992	1.9%	5,734	1,156	1.9%	6,890	1.9%
13	1,188	636	9.0%	1,824	1,420	5.9%	3,244	1,661	4.2%	4,905	5.8%
14	5,286	1,195	4.2%	6,481	2,679	3.5%	9,160	3,125	3.0%	12,285	3.4%
15	9,402	636	1.3%	10,038	1,437	1.3%	11,475	1,682	1.4%	13,157	1.4%
16	2,370	1,548	10.6%	3,918	3,485	6.6%	7,403	4,062	4.5%	11,465	6.5%
17	13,289	1,867	2.7%	15,156	4,214	2.5%	19,370	4,904	2.3%	24,274	2.4%
18	1,127	613	9.1%	1,740	1,369	6.0%	3,109	1,604	4.2%	4,713	5.9%
19	4,878	1,260	4.7%	6,138	2,836	3.9%	8,974	3,304	3.2%	12,278	3.8%
20	1,254	95	1.5%	1,349	212	1.5%	1,561	246	1.5%	1,807	1.5%
21	9,774	1,823	3.5%	11,597	4,116	3.1%	15,713	4,786	2.7%	20,499	3.0%
22	1,189	109	1.8%	1,298	244	1.7%	1,542	284	1.7%	1,826	1.7%
23	432	14	0.6%	446	24	0.5%	470	34	0.7%	504	0.6%
24	620	119	3.6%	739	267	3.1%	1,006	311	2.7%	1,317	3.1%
25	694	14	0.4%	708	32	0.4%	740	41	0.5%	781	0.5%
26	736	156	3.9%	892	345	3.3%	1,237	405	2.9%	1,642	3.3%
27	319	89	5.0%	408	201	4.1%	609	237	3.3%	846	4.0%
28	435	6	0.3%	441	11	0.2%	452	13	0.3%	465	0.3%
29	187	35	3.5%	222	84	3.3%	306	96	2.8%	402	3.1%
30	4,949	506	2.0%	5,455	1,224	2.0%	6,679	1,600	2.2%	8,279	2.1%
31	909	103	2.2%	1,012	236	2.1%	1,248	312	2.3%	1,560	2.2%
32	1,888	209	2.1%	2,097	506	2.2%	2,603	658	2.3%	3,261	2.2%
33	8,534	683	1.6%	9,217	1,643	1.7%	10,860	2,148	1.8%	13,008	1.7%
34	5,339	1,678	5.6%	7,017	3,755	4.4%	10,772	4,381	3.5%	15,153	4.3%
35	901	219	4.4%	1,120	505	3.8%	1,625	626	3.3%	2,251	3.7%
36	721	129	3.3%	850	294	3.0%	1,144	341	2.6%	1,485	2.9%
37	260	39	2.8%	299	76	2.3%	375	96	2.3%	471	2.4%
38	2,910	339	2.2%	3,249	754	2.1%	4,003	883	2.0%	4,886	2.1%
39	2,959	426	2.7%	3,385	947	2.5%	4,332	1,112	2.3%	5,444	2.5%
40	6,474	543	1.6%	7,017	1,236	1.6%	8,253	1,439	1.6%	9,692	1.6%
41	20,421	844	0.8%	21,265	1,908	0.9%	23,173	2,221	0.9%	25,394	0.9%
42	8,878	598	1.3%	9,476	1,348	1.3%	10,824	1,564	1.4%	12,388	1.3%
43	47,982	2,473	1.0%	50,455	5,527	1.0%	55,982	6,436	1.1%	62,418	1.1%
Area Total	278,053	31,327	2.2%	309,380	70,882	2.1%	380,262	83,578	2.0%	463,840	2.1%

(1) AAPC - Average Annual Percent Change



**TOTAL CHANGE IN HOUSEHOLDS
FROM 2015 TO 2040: TRMv5**

3. Identify improvements that added capacity and had the potential to impact traffic volumes on the Triangle Expressway or Complete 540. Of interest was identifying long-range, non-committed projects that could strongly influence the usage of the Triangle Expressway or Complete 540.

Based on the review, the assumed improvements in the TRMv5 model were maintained. Although the assumed opening dates were revised based on conversations with NCDOT staff. **Table 3.3** lists some of the assumed roadway improvements that add capacity to roads in the study area. This list is not all inclusive. Some of the improvement projects fall outside of the STIP timeframe, but are included as they are identified in long range plans or in the TRMv5 model.

Figure 3.4 illustrates the projects listed in Table 3.3. The improvements are color coded to indicate the anticipated timeframe of completion. Of interest are several large projects:

1. I-40: The planned widening of I-40 from the Beltline to NC 42 (Project ID I-5111), by adding an additional general-purpose lane in each direction. The completion date for this improvement is January 2022. This is a toll-free roadway that will compete with Segment 3 of Complete 540.
2. I-40: The non-committed project to add one managed lane in each direction on I-40 from U.S. 501 to Wade Avenue (Project IDs I-5702A and I-5702). This project was included in the TRMv5 and was listed as a long-range plan, although not funded, with a completion date in 2030. The project was included for conservative purposes, as it improves the capacity on I-40 which competes to some extent with Complete 540.
3. I-40/I-440: The non-committed project to add one managed lane in each direction on I-40/I-440 from Wade Avenue to U.S. 64/264/Knightdale Bypass (Project ID FS-1005A). This project was in the TRMv5 and was included in this study for conservative purposes as it improves the capacity on I-40/I-440 which competes to some extent with Complete 540.
4. I-540: The non-committed plan to add one managed lane per direction to the northern outer loop of I-540 from I-40 to U.S. 64/264/Knightdale Bypass (Project ID FS-1305A). This project is included in the TRMv5 in model year 2030 and was included in this study in model year 2025. This project was included for conservative purposes, as it represents an improvement to a potentially competing road.

Table 3.3
Selected Future-Year Roadway Improvements
Assumed in the Current Complete 540 Traffic and Revenue Study

Project STIP/MTP ID	Roadway	Location	Description	Assumed Opening Date
Calendar Years 2019 - 2020				
U-5315	Morrisville Parkway	SR 1600 / SR 1625 (Green Level Church Road) to East of NC 55	Multi-lane Facility on New Location, Including Interchange at Toll 540 (Triangle Expressway)	Jan. 2019
U-5746	US 401	Future NC 540 to SR 1010 (Ten-Ten Road)	Widen from 4 to 6 Lanes	Jan. 2019
Calendar Years 2021 - 2025				
FS-1305A	I-540	NC 54 to US 64/264	One Managed Lane per Direction	Jan. 2025
U-2719	I-440 / US 1	South of SR 1313 (Walnut Street) to North of SR 1728 (Wade Avenue)	Widen from 4 to 6 Lanes, Improve Storage at Lake Boone Trail Interchange and Install Ramp Meters	Jan. 2023
U-2901AC	NC 55	US 1 to Apex Peakway	Convert Current Multilanes to Median Divided Section	Jan. 2022
U-2901B	NC 55	Apex Peakway to Bryan Drive	Widen Remaining 2-Lane Sections to 4 Lanes	Jan. 2022
R-3410B	NC 42	NC 50 to US 70 Bypass	Widen from 2 to 4 Lanes	Jan. 2023
I-5111	I-40	I-40/I-440 Split (Exit 301) TO NC 42 (Exit 312)	Add 1 General Purpose Lane Per Direction	Jan. 2022
I-5506	I-40	SR 1002 (Aviation Parkway) to SR 3015 (Airport Boulevard)	Improve SR 1002 (Aviation Parkway) Interchange and Construct Auxiliary Lane on I-40 Westbound from SR 1002 (Aviation Parkway) to SR 3015 (Airport Boulevard)	Jan. 2021
I-5700	I-40	SR 3015 (Airport Boulevard) to I-540	Revise SR 3015 (Airport Boulevard) Interchange and Construct Auxiliary Lane on I-40 Westbound from SR 3015 (Airport Boulevard) to I-540	Jan. 2023
I-5707	I-40	NC 55 to NC 147 (Triangle Expressway)	Construct Westbound Auxiliary Lane	
U-5750	NC 54	NC 540 to Perimeter Park Drive	Add 1 or 2 Lanes in Each Direction	Jan. 2023
U-5811	SR 1002	NC 54 to I-40	Widen to 4 Lanes with Interchange Modifications at I-40	Jan. 2022
U-5825A	SR 1010	Apex Peakway to Reliance Avenue	Widen from 2 to 4 Lanes	Jan. 2025
U-5825B	SR 1010	Reliance Avenue to Kildaire Farm Road	Widen from 2 to 4 Lanes	Jan. 2022
U-5827	SR 1632	Poplar Pike Lane in Morrisville to SR 2123 (Little Drive)	Construct 1 to 2 Lane Roadway on New Location	Jan. 2021
U-5828	McCrimmon Parkway	SR 3015 (Airport Boulevard) to SR 1002 (Aviation Parkway)	Widen Existing Portion to 4 Lanes, Extend New 2-Lane Roadway	Jan. 2022
I-5966	I-40	SR 1002 (Aviation Parkway) to SR 1652 (Harrison Avenue)	Construct 1 Auxiliary Lane in Both Directions	Jan. 2025
Calendar Years 2026 - 2030				
U-5500	SR 1605 / SR 1615	SR 1600 (Green Level Church Road) to NC 55	Widen from 2 to 4 Lanes	Jan. 2030
I-5701	I-40	I-440 / US 64 to Lake Wheeler Road	Add 1 General Purpose Lane Per Direction	Jan. 2030
I-5702A	I-40	US 15 / US 501 to NC 147	Construct 1 Managed Lane Per Direction	Jan. 2030
I-5702B	I-40	NC 147 (Triangle Expressway) to SR 1728	Construct 1 Managed Lane Per Direction	Jan. 2030
U-5936	SR 1728	I-40 to I-440	Add 1 General Purpose Lane Per Direction	Jan. 2028
Calendar Years 2031 - 2040				
F15a	US 64	US 1/64 to I-540	Widen from 4 to 6 lanes	Jan. 2040
F110	US 1	US 64 to NC 540	Widen from 4 to 6 lanes	Jan. 2040
A113	SR 1010	Holly Springs Rd to Bells Lake Rd	Widen from 4 to 6 lanes	Jan. 2040
A300	US 70	US 401 to I-40	Widen from 4 to 6 lanes	Jan. 2040
A301	US 70	I-40 to NC 42	Widen from 4 to 6 lanes	Jan. 2040
A400a	SR 1010	Bells Lake Rd to Old Stage Rd	Widen from 4 to 6 lanes	Jan. 2040
FS-1005A	I-40	SR 1728 (Wade Avenue) to I-440 / US 64	Construct 1 Managed Lane Per Direction	Jan. 2040

3.4 Model Refinement and Calibration

CDM Smith created a 2016 network and trip tables, based on the TRMv5 2015 network and 2015 and 2020 trip tables. The 2016 trip table was created by interpolating between the 2015 and 2020 trip tables. This section describes the reviews and modifications that were made to the TRMv5 network and trip tables to develop the 2016 and future year networks and trip tables.

CDM Smith already had experience with the TRMv5 as it was used in the **2014 NCDOT I-40/I-440 Managed Lanes Study (NCDOT STIP I-5111 and FS-1005A)**. During the 2014 NCDOT I-40/I-440 Study, the TRMv5 was modified by CDM Smith to improve calibration and to reflect more detail in the study corridor. Changes included adjusting some centroid connectors, adding new road links, disaggregating some TAZs, and validating link distances and number of lanes. These revisions were reviewed and carried through to the current study. The following describes additional reviews and modifications that were made to the TRMv5 as part of the current study.

3.4.1 Triangle Expressway and Complete 540 Configuration and Toll Concept

Figures 3.5 through 3.9 provide not-to-scale schematics of the existing Triangle Expressway and Complete 540 that show interchange configurations, numbers of through travel lanes, centerline distances between interchanges, and tolling-zone locations. Gantries shown in Figures 3.5 through 3.9 are not exact locations; they indicate the presence of a toll zone on a ramp or mainline section.

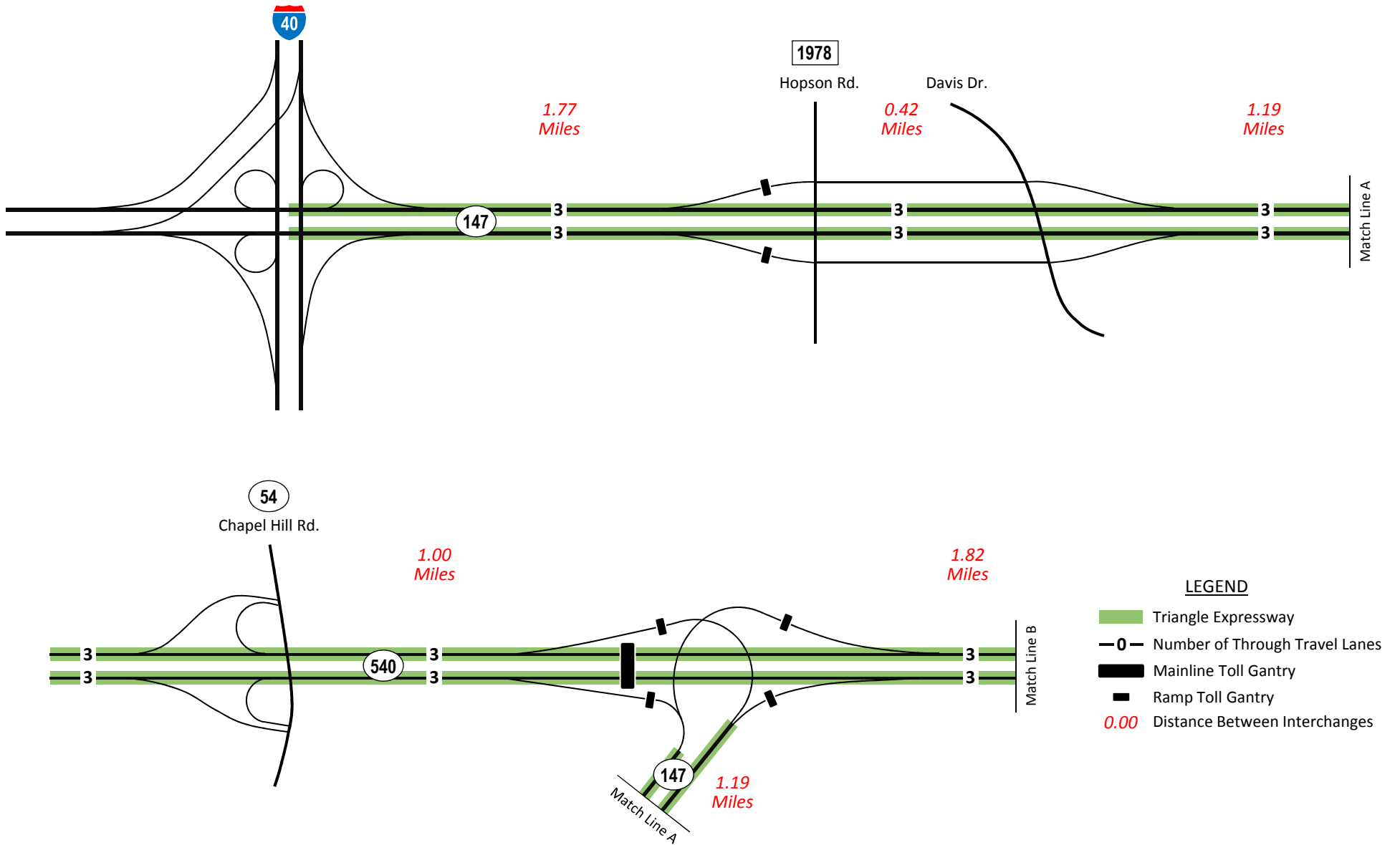
Figures 3.5 through 3.7 portray the Triangle Expressway from north to south, and Figures 3.7 through 3.9 portray Complete 540 from west to east. These schematics are based on available mapping and aerials of the Triangle Expressway and on plans for Complete 540 provided by the NCTA.

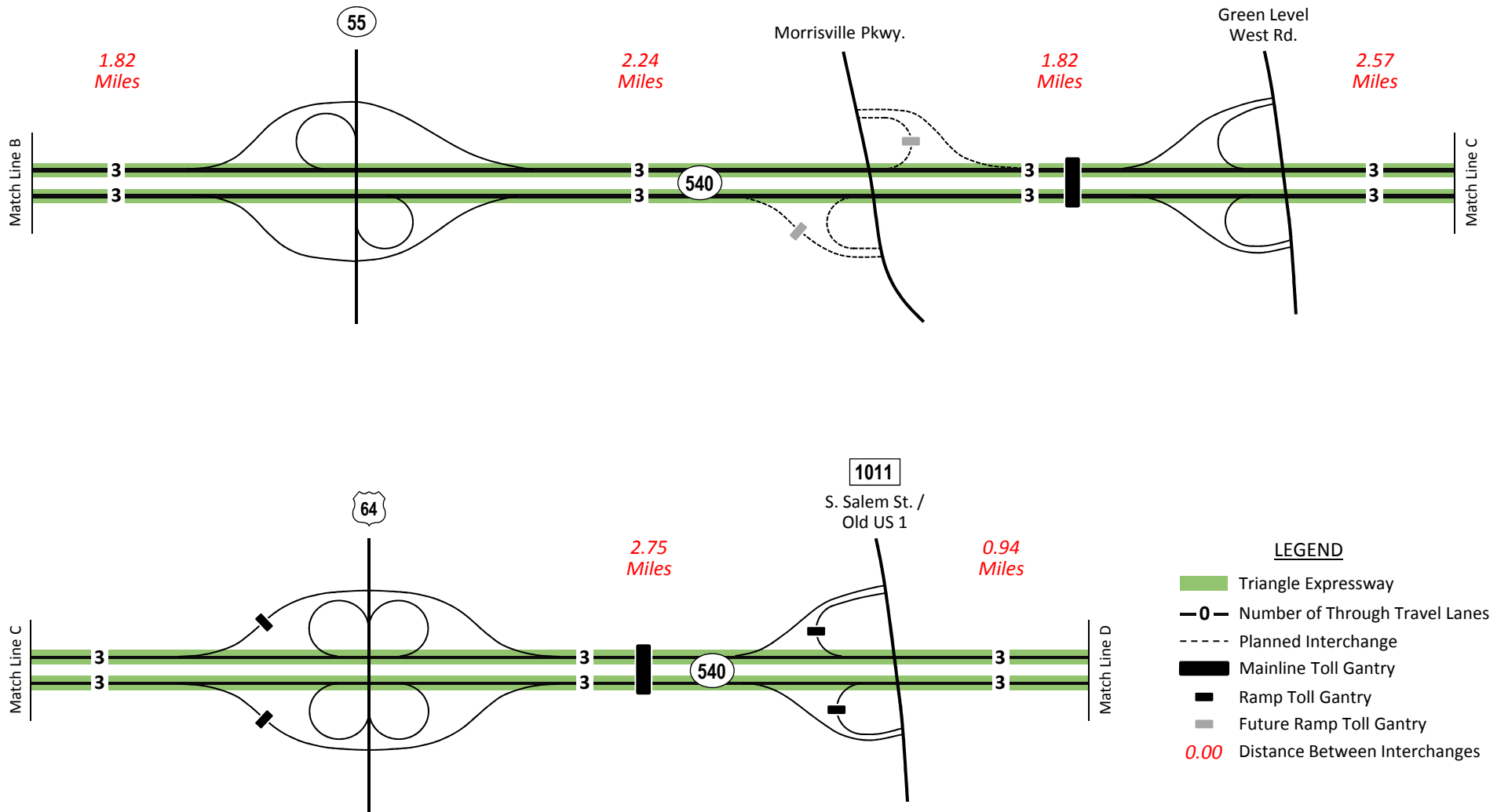
Complete 540 will be a 27.5-mile, six-lane controlled-access facility extending from the NC 55 Bypass at the southern terminus of the Triangle Expressway to I-495/US 64/264 (Knightdale Bypass) east of Raleigh, with 11 intermediate interchanges and 12 mainline toll gantries. Segment 1 from the NC 55 Bypass to US 401 will have interchanges with SR 1152 (Holly Springs Road), 1386 (Bells Lake Road), and US 401 (Fayetteville Road). Segment 2 will have interchanges with SR 1006 (Old Stage Road), NC 50 (Benson Road), and I-40. Segment 3 will have interchanges with SR 2700 (White Oak Road), US 70 Business, SR 2542 (Rock Quarry Road), SR 2555 (Auburn Knightdale Road), SR 1007 (Poole Road), and US 264 (Knightdale Bypass). In this study, it is assumed that a toll zone will be located on each mainline section of Complete 540 as shown in Figures 3.7 through 3.9.

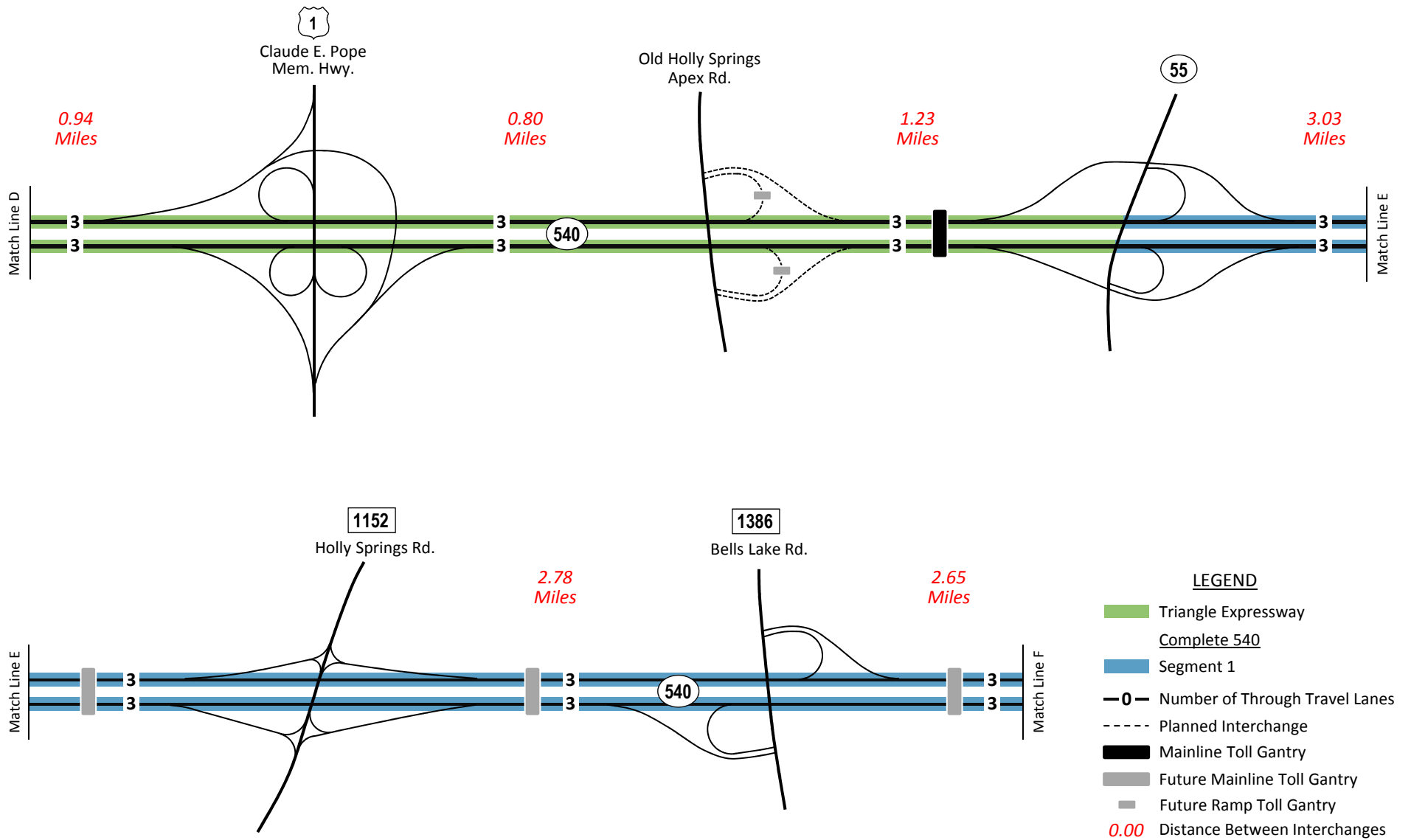
The TRMv5 model includes the Triangle Expressway and the Complete 540. The network coding of these projects was checked against aerials and against plans for Complete 540 provided by the NCTA. Minor changes were made so the network coding matched ground conditions for the Triangle Expressway and the plans for Complete 540. A speed limit of 70 mph was assumed for modeling the Triangle Expressway and Complete 540.

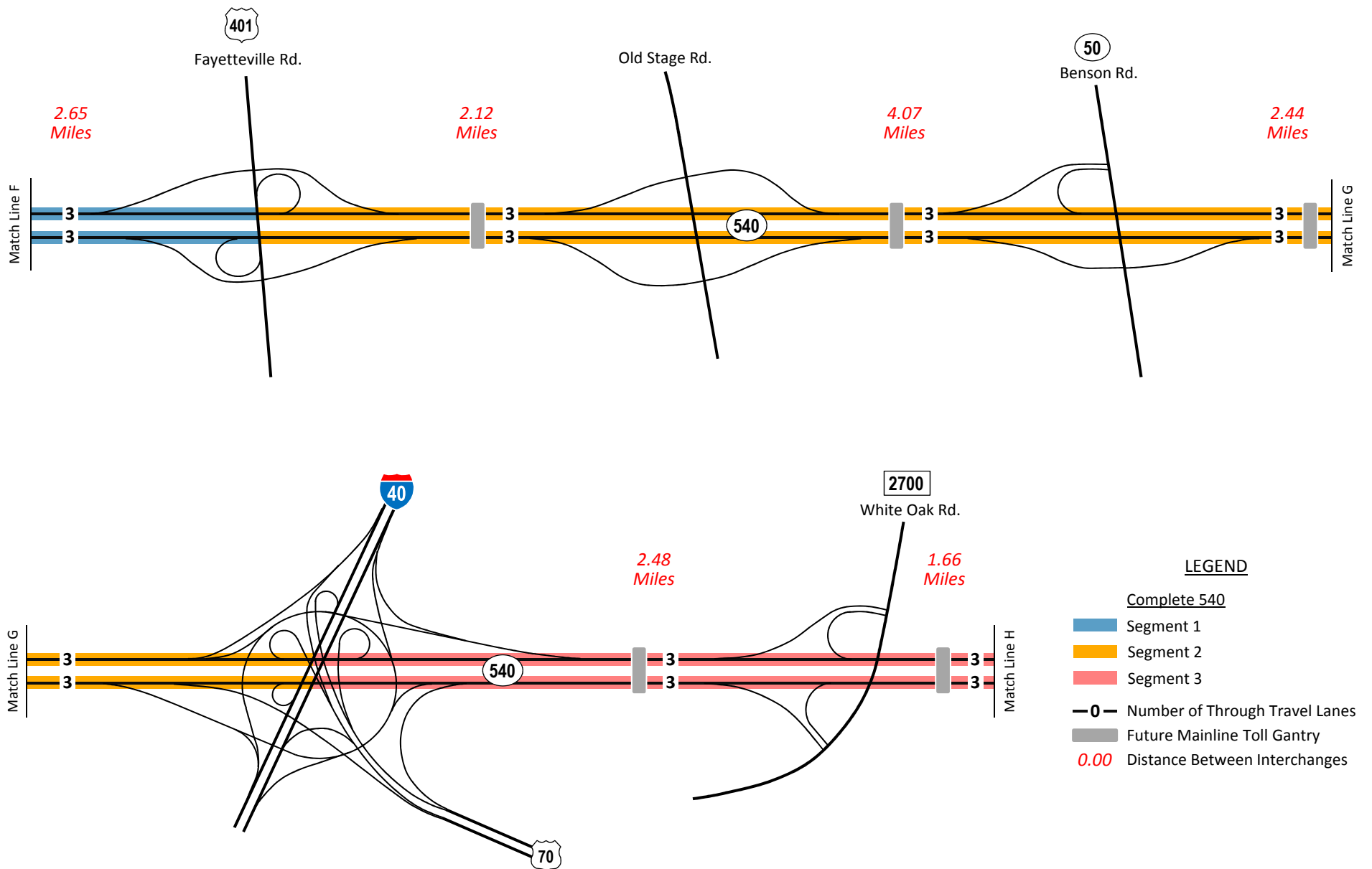
3.4.2 Other Network Modifications

The network in the Triangle Expressway and Complete 540 corridors was reviewed for centroid connection locations, free-flow and congested travel speeds, capacities, TAZ size, and to determine if additional road links were needed. Only minor modifications were made, consisting primarily of input speeds, centroid connectors, and the addition of some auxiliary lanes. Most of these changes were made in the Triangle Expressway/NC 55 corridor.

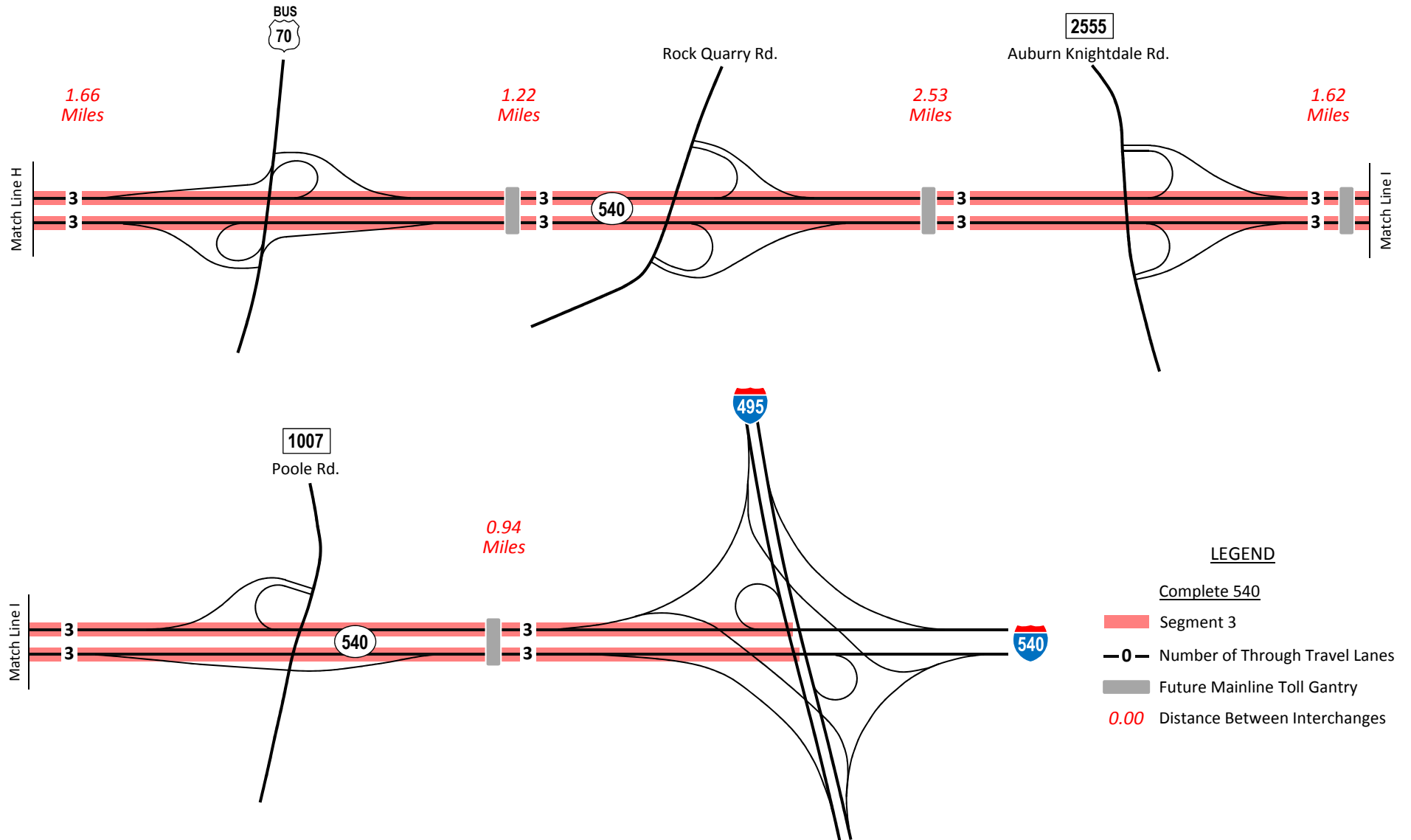








**PROJECT CONFIGURATION
COMPLETE 540 FROM US 401 TO WHITE OAK ROAD**



3.4.3 Model Calibration

After network modifications were made, the TRMv5 model was calibrated in select locations to 2016 weekday conditions. The calibration relied on the traffic counts conducted by The Traffic Group, NCDOT AADT maps, NCTA traffic data on the Triangle Expressway, INRIX/HERE travel speeds, and origin-destination data from StreetLight Data. The calibration effort focused on the eight screenlines developed by CDM Smith, the Triangle Expressway, NC 55, and I-40. During calibration, the 2016 trip table was modified at key locations to adjust to targeted 2016 weekday traffic volumes at traffic count locations.

The StreetLight data was used to benchmark trip-distance (origin-destination) distributions at key locations in the TRMv5 model to actual data. Trip distance distributions were examined on the Triangle Expressway, and on I-40 (as I-40 trips have the potential to shift to Complete 540 depending on length and entry/exit locations). Figure 3.10 shows an example of StreetLight trip- distribution data on the Triangle Expressway. Location 1.9 (designated by a red star), is the destination zone on the mainline section of Toll 147 between Davis Drive and Toll 540. The percent trip-distribution of Location 1.9 northbound weekday traffic is shown at downstream locations. For example, of the total traffic passing through Location 1.9 in the northbound direction, 51.4 percent also passed through Location 1.5, and 15.4 percent passed through Location 1.1.

Another example, shown in **Figure 3.11**, shows I-40 trip distance-distance data for northbound/westbound travel on I-40 through Location 2.2. Of the traffic passing through Location 2.2 (I-40 between Davis Drive and S. Miami Boulevard) 48.3 percent passed through nearby Location 2.3. Only 3.2 percent passed through Location 3.2. Less than one percent passed through locations 1.8 or 1.4 on the Triangle Expressway, or Location 5.4 on NC 55.

CDM Smith determined that the TRMv5 2016 trip distances were adequate in the study area for this planning level study. No trip table adjustments were made based on the StreetLight Data.

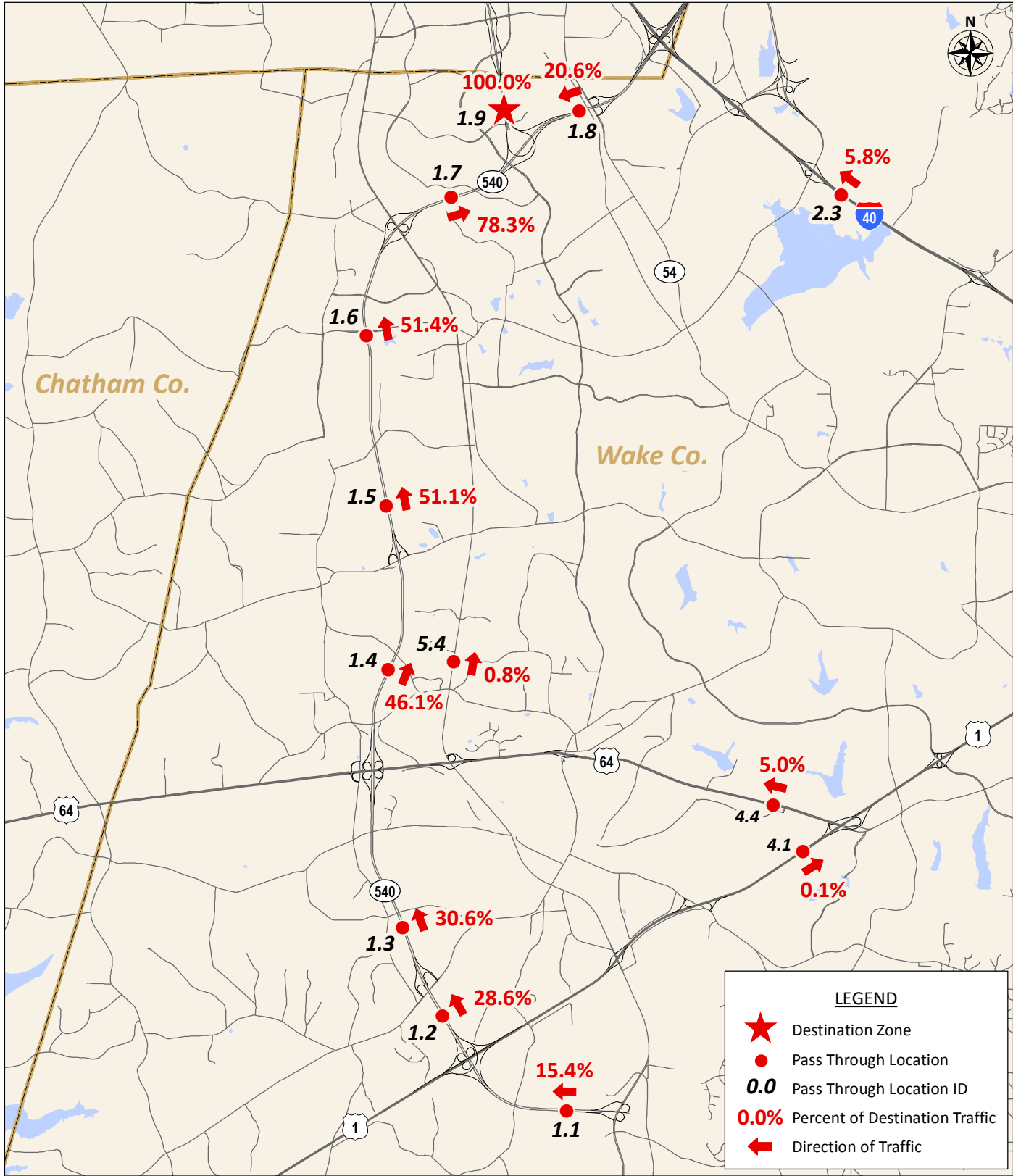
3.4.4 Future Year Adjustments and Assignments

Network and trip table adjustments were carried through to future-year networks. The TRMv5 supports future years 2020, 2030 and 2040. CDM Smith created networks and trip tables for 2017, 2019 and 2025 in order to conduct assignments to reflect the opening of the Veridea Parkway Interchange in 2017, the opening of the Morrisville Parkway Interchange in 2019, and the opening of Complete 540 segments in 2025. The assignments are described in more detail in Section 4.2.

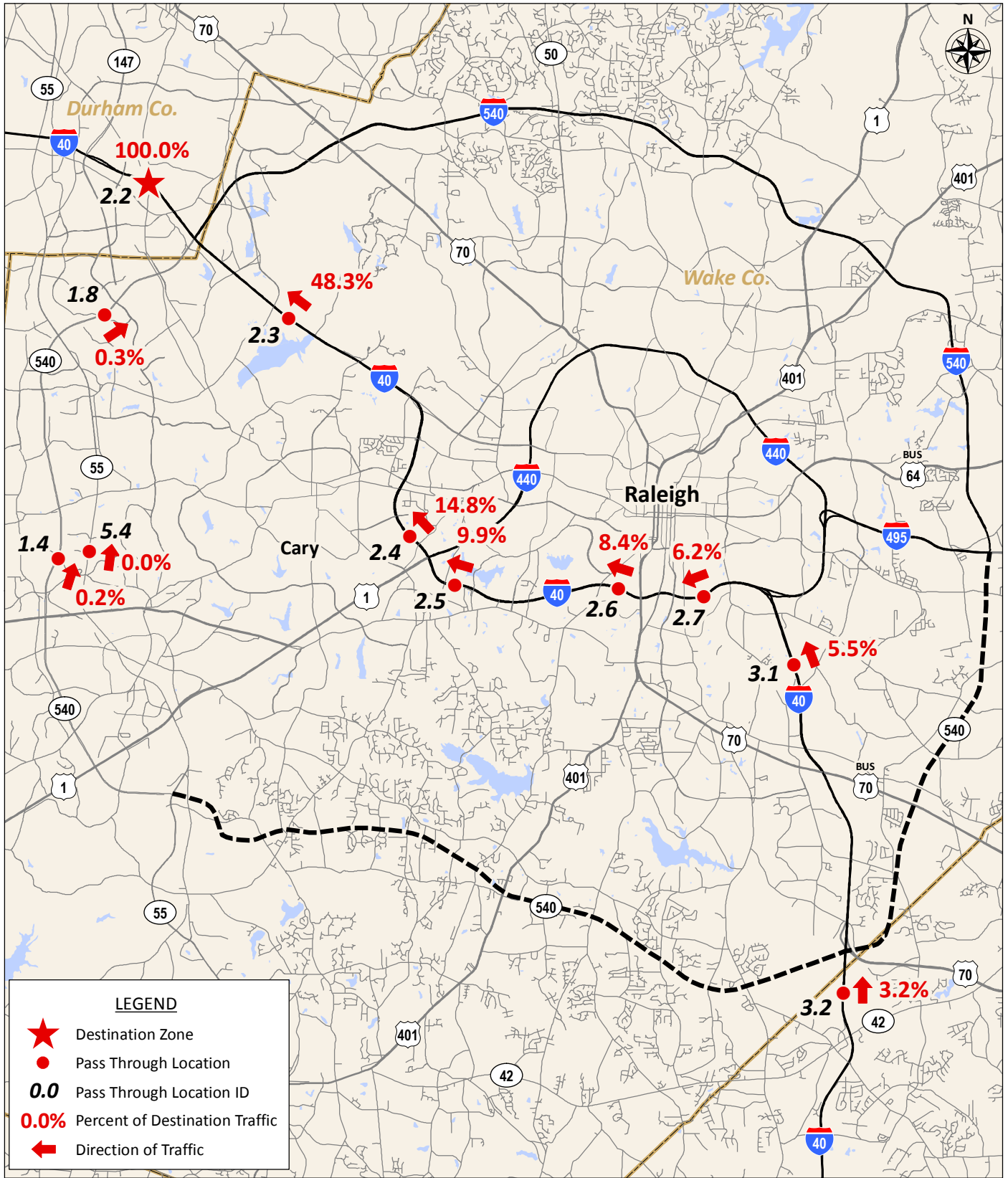
3.4.5 Next Generation of TRM

All assignments were based on the TRMv5 assumed land uses and demographics, and used the TRMv5 trip tables. CDM Smith did not re-run the model's four-step process to generate new trip tables. The TRM model is in the process of being updated by ITRE to a TRMv6 with updated land uses, demographics, and road improvements.

Traffic and toll revenue estimates for the Triangle Expressway and Complete 540 are likely to change based on the new assumptions in the TRMv6. In addition, if traffic and toll revenue forecasts are developed for an investment grade study, the land use assumptions and demographics will be subject to an independent review and modifications by an economist that specializes in the study area's growth and development.



**AVERAGE WEEKDAY STREETLIGHT
ORIGIN-DESTINATION SAMPLE
LOCATION 1.9 NB**



**AVERAGE WEEKDAY STREETLIGHT
ORIGIN-DESTINATION SAMPLE
LOCATION 2.2 NB/WB**

Chapter 4 - Draft

Traffic and Revenue Forecasts

This chapter presents a summary of the traffic and revenue analysis conducted for the Triangle Expressway and Complete 540. In addition to an overview of the travel demand modeling process, this chapter also presents information about basic assumptions and modeling inputs, toll rates, and traffic and toll revenue forecasts for the Triangle Expressway and Complete 540 for each scenario.

4.1 Summary of Study Methodology

This section describes the methodology used to develop the annual toll traffic and adjusted toll revenue. A more detailed account of the traffic demand model and the roadway improvements is provided in Chapter 3.

CDM Smith conducted the traffic and revenue study using the currently adopted Triangle Regional Model version 5 (TRMv5). This model's base year is 2010, and it supports future-year trip tables and networks for 2015, 2020, 2030 and 2040. The TRM includes highway and transit networks and land-use and socio-economic data for each model year. Transit and vehicle trip tables are derived from the model.

4.1.1 Model Refinement and Calibration

CDM Smith developed a 2016 network and trip tables, and calibrated the model to 2016 conditions in the Triangle Expressway and Complete 540 corridor. The 2016 trip tables were developed by interpolating between the TRMv5 2015 and 2020 trip tables. In developing the 2016 network, a comparison was made between the 2015 network and actual ground conditions observed in aerials available on the internet. These comparisons were made to validate the 2016 network in the study area against current conditions.

During the calibration process, CDM Smith reviewed and modified the 2016 network by disaggregating TAZs, changing centroid connections, and adding additional roads or road segments to the networks. The 2016 model was calibrated in the Triangle Expressway and Complete 540 corridor by comparing model results with known traffic volumes and travel speeds. StreetLight Data origin-and-destination information was used to check study-area travel patterns within the model for reasonableness. Some trip table adjustments were made at select locations to improve calibration to known traffic volumes. The TRMv5 travel patterns adequately reflected the travel patterns observed from StreetLight Data on the selected roads so no trip table adjustments were made to modify travel patterns or trip distances. Changes in the model necessary to achieve calibration in 2016 were carried forward into the future year networks and trip tables.

Data used for the calibration effort included:

1. Traffic volumes from the NCDOT and NCTA, as well as traffic counts conducted for CDM Smith by The Traffic Group.

2. Travel speed data from INRIX and HERE.
3. Origin-destination data obtained from StreetLight Data.
4. Historical method-of-payment market shares between ETC and video on the Triangle Expressway.
5. Estimates of motorist values-of-time and vehicle operating cost.

4.1.2 Future Year Networks and Trip Tables

CDM Smith developed networks and trip tables for 2017, 2019 and 2025. These were created to model the opening year of the Veridea Parkway Interchange on the Triangle Expressway (2017), the Morrisville Parkway Interchange on the Triangle Expressway (2019), the 147 Toll Extension on the Triangle Expressway, and Complete 540 Segments 1 and 2 (2025). The new trip tables were created by interpolating between existing trip-table years, and the new networks were developed from an adjacent year and adding or subtracting roadway improvements.

Planned roadway improvements assumed in the TRMv5 were compared to current roadway improvement plans and changes were made when necessary. The assumed roadway improvements are described in Chapter 3. Roadway improvements that were assumed in the TRMv5 were maintained, although some changes in the assumed opening year were made after consultation with the NCDOT.

4.1.3 Traffic Diversion Analysis

Toll diversion assignments were run for years 2017, 2019, 2025, 2030 and 2040. The assignments were run by eight time-periods, two vehicle classes (car and truck), and two methods-of-payment (ETC and video).

In the future-year toll diversion assignments, the NCTA adopted toll schedule was used for the Triangle Expressway. Assumed toll rates on Complete 540 are based on the through-trip per-mile toll rate on the Triangle Expressway for each assignment year. The toll schedule adopted by the NCTA assumes an annual toll rate increase to keep pace with inflation forecasts. Toll-rate structure assumptions are described in Section 4.3 and assumed toll rates are described in Section 4.4

The toll diversion assignments result in calendar-year average annual weekday traffic forecasts by toll zone on the Triangle Expressway and Complete 540. Weekday traffic volumes for non-assignment years were interpolated from adjacent assignment years. Weekday traffic forecasts for years beyond 2040 (the last assignment year) were developed by assuming an annual increase based on decreasing the prior trend line.

Average weekday traffic volumes were converted into annual volumes at each toll zone by applying an annualization factor. The factor accounts for the number of weekdays, week-end days, and holidays in a year, and the differing traffic volumes that occur on those days. An annualization factor of 308 was used, meaning the annual traffic is equivalent to 308 days of weekday traffic. The factor was derived from one complete year of 2016 daily traffic data from all tolled locations on the Triangle Expressway. Annual toll revenue estimates were calculated by multiplying annualized traffic volumes for each toll zone by the corresponding toll rate. Traffic and toll revenue forecasts

were developed first for calendar years, because the TRM model operates on a calendar year basis. The forecasts were then converted to the NCDOT fiscal year, which begins on July 1.

For purposes of this study, revenue leakage due to unreadable or uncollectible ETC or video transactions, or any transactions that cannot be processed and payment collected, were assumed to be offset by fee revenue as observed in actual experience on the Triangle Expressway.

4.2 Model Assignments

Table 4.1 summarizes the model assignments required for the study scenarios described in Chapter 1 and shown in **Figure 1.1**. The assignments were designed to establish an updated traffic and revenue forecast for the existing Triangle Expressway, and estimate the traffic and toll revenue impacts associated with extending the Triangle Expressway eastward for the different Complete 540 alternatives. A no-build condition (Scenario 0) was analyzed to provide a baseline comparison with the build conditions. Scenario 0 assumed there were no improvements to the Triangle Expressway and Complete 540 would not be constructed. Scenario 1, the Triangle Expressway Base Build Condition, assumes the existing Triangle Expressway and its two new interchanges, the Veridea Parkway Interchange and the Morrisville Parkway Interchange. No sections of Complete 540 are assumed to be constructed. Scenarios 2 through 4 assume the Triangle Expressway Build condition, and the addition of progressively more segments of Complete 540. Scenario 1.1 tests the impact of an extension of Toll 147 southward to McCrimmon Parkway on Scenario 1. Scenario 1.1 assumptions are not carried forward to Scenarios 2, 3, or 4.

4.3 Basic Assumptions

4.3.1 Toll Collection on Complete 540

Complete 540 toll collection is assumed to be consistent with the Triangle Expressway's toll structure. Tolls will be collected via NC Quick Pass (NCDOT's ETC program) or by Bill by Mail (BBM), NCDOT's video toll collection program. The NC Quick Pass program is currently interoperable with Georgia's Peach Pass, Florida's Sun Pass and E-ZPass. Throughout this study, ETC refers to NC Quick Pass and the other interoperable systems. This interoperability arrangement is assumed to continue through the forecast period of this study.

All vehicles will be permitted to use Complete 540. The following three toll classes will be implemented:

- Class 1 (2-axle vehicles): all two-axle vehicles regardless of the number of tires.
- Class 2 (3-axle vehicles): all three-axle vehicles including two-axle vehicles towing a single-axle trailer.
- Class 3 (4-or-more axle vehicles): all vehicles with four-or-more axles (4+) including two-axle vehicles towing a dual-axle trailer.

Motorists who pay with NC Quick Pass (or interoperable systems) will receive a 35 percent discount from the BBM rates. Class 2 toll rates will equal two times the Class 1 toll rate, and Class 3 toll rates will equal four times the Class 1 toll rate.

**Table 4.1
Model Assignments**

Scenario	Existing 2016	Future Year Assignments				
		2017	2019	2025	2030	2040
Scenario 0 (Triangle Expressway Calibration and Future No-Build)						
Triangle Expressway - No Improvements	x	x	x	x	x	x
Scenario 1 (Triangle Expressway Base Build)						
Triangle Expressway	x					
Veridea Pkwy Interchange		x	x	x	x	x
Morrisville Pkwy Interchange			x	x	x	x
Scenario 1.1 (Triangle Expressway Sencitivity Test - Toll 147 Ext)						
Triangle Expressway	x					
Veridea Pkwy Interchange		x	x	x	x	x
Morrisville Pkwy Interchange			x	x	x	x
Toll 147 Ext. to McCrimmon Pkwy			x	x	x	x
Scenario 2 (Complete 540 from NC 55 Bypass to U.S. 401)						
Triangle Expressway (Scenario 1)	x					
Veridea Interchange		x	x	x	x	x
Morrisville Pkwy Interchange			x	x	x	x
Complete 540						
Segment 1: NC 55 Bypass to U.S. 401				x	x	x
Scenario 3 (Complete 540 from NC 55 Bypass to Interstate 40)						
Triangle Expressway (Scenario 1)	x					
Veridea Pkwy Interchange		x	x	x	x	x
Morrisville Pkwy Interchange			x	x	x	x
Complete 540						
Segment 1: NC 55 to U.S. 401				x	x	x
Segment 2: U.S. 401 to I-40				x	x	x
Scenario 4 (Complete 540 from NC 55 Bypass to U.S. 64/264 Bypass)						
Triangle Expressway (Scenario 1)	x					
Veridea Pkwy Interchange		x	x	x	x	x
Morrisville Pkwy Interchange			x	x	x	x
Complete 540						
Segment 1: NC 55 Bypass to U.S. 401				x	x	x
Segment 2: U.S. 401 to I-40				x	x	x
Segment 1: I-40 to U.S.64/264 Bypass					x	x

Note: Highlight indicates change in configuration compared to prior scenario.

4.3.2 Other Basic Assumptions

The traffic and revenue estimates for the Triangle Expressway and Complete 540 are predicated on the following basic assumptions, which are considered reasonable for purposes of this study:

1. The assumed opening dates for improvements on the Triangle Expressway and sections of Complete 540 occur on the first day of the indicated year in Table 4.1

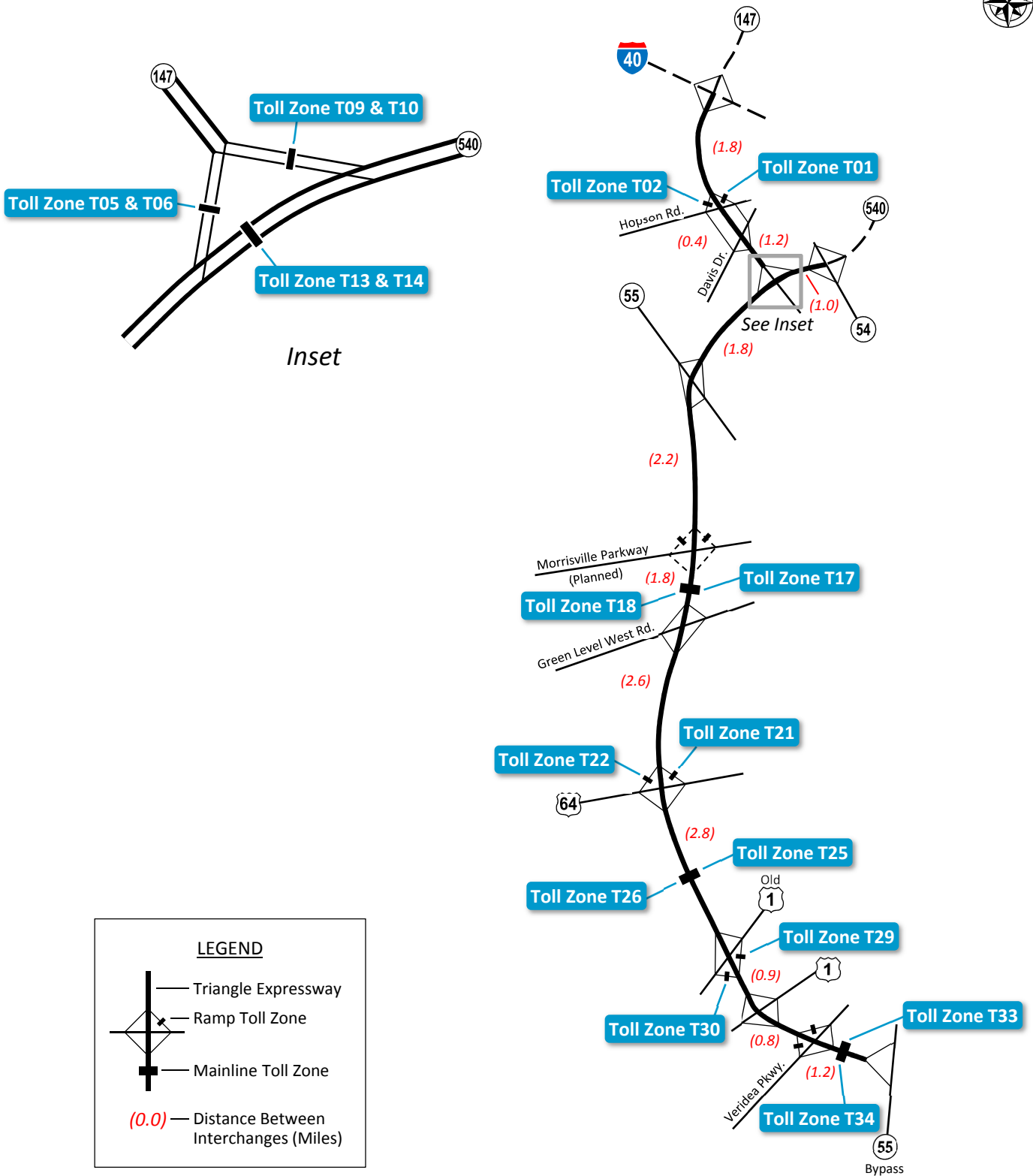
2. Tolls will be charged for the three vehicle classes and two payment types described in Section 4.3.1 Toll Collection. The toll rates will be increased annually to keep up with inflation. The toll rates and tolling zone locations are provided in Section 4.4 Future Year Toll Rate Assumptions.
3. No transportation improvement projects, particularly new roads, additional road capacity, or new interchanges on limited access roads will be constructed during the forecast period, other than those included in the TRMv5. Assumed roadway improvements are discussed in Chapter 3.
4. The annual percentage of ETC and BBM transactions will match the assumed market shares described in Section 4.5.1.
5. Economic growth in the project study area by TAZs will occur as forecast in the socioeconomic data contained in the TRMv5.
6. Revenue leakage due to unreadable or uncollectible ETC or BBM transactions, or any transactions that cannot be processed and payment collected, will be offset by fee revenue as observed in actual experience on the Triangle Expressway.
7. Annual inflation rates are assumed to be 2.0 percent per year throughout the forecast period.
8. Motor fuel will remain in adequate supply throughout the forecast period. Fuel price forecasts were obtained from the U.S. Energy Information Administration in a report titled *Annual Energy Outlook 2015 with projections to 2040*. The forecast fuel costs were incorporated into the estimated vehicle operating costs.
9. No national or regional emergency will arise that would abnormally restrict the use of motor vehicles.

Any significant departure from these basic assumptions could materially affect traffic and revenue potential on the Triangle Expressway and Complete 540.

4.4 Future Year Toll Rate Assumptions

4.4.1 Triangle Expressway Toll Rate Schedule

Table 4.2 shows Triangle Expressway Class 1 ETC and video toll rates, by tolling zone, from 2016 through 2055. The toll zone locations are shown in **Figure 4.1**. Toll rates on the Triangle Expressway through 2051 have been officially adopted by the NCDOT, including the rates at the recently opened Veridea Parkway. Toll rates have been officially adopted for the Morrisville. Toll rates for the proposed Toll 147 Extension (Scenario 1.1) are presented in Section 4.8.



In all years, Class 2 rates are double Class 1 rates, and Class 3 rates are four times Class 1 rates. ETC toll rates receive a 35 percent discount from video toll rates. Annual rate adjustments take place each January 1 to account for the impacts of annual inflation.

Toll rates increase by an average of 2.9 percent per year from 2016 through 2051. Annual rate increases decrease over time, averaging 3.3 percent per year from 2016 through 2025, and decreasing to 1.2 percent or less from 2040 through 2055.

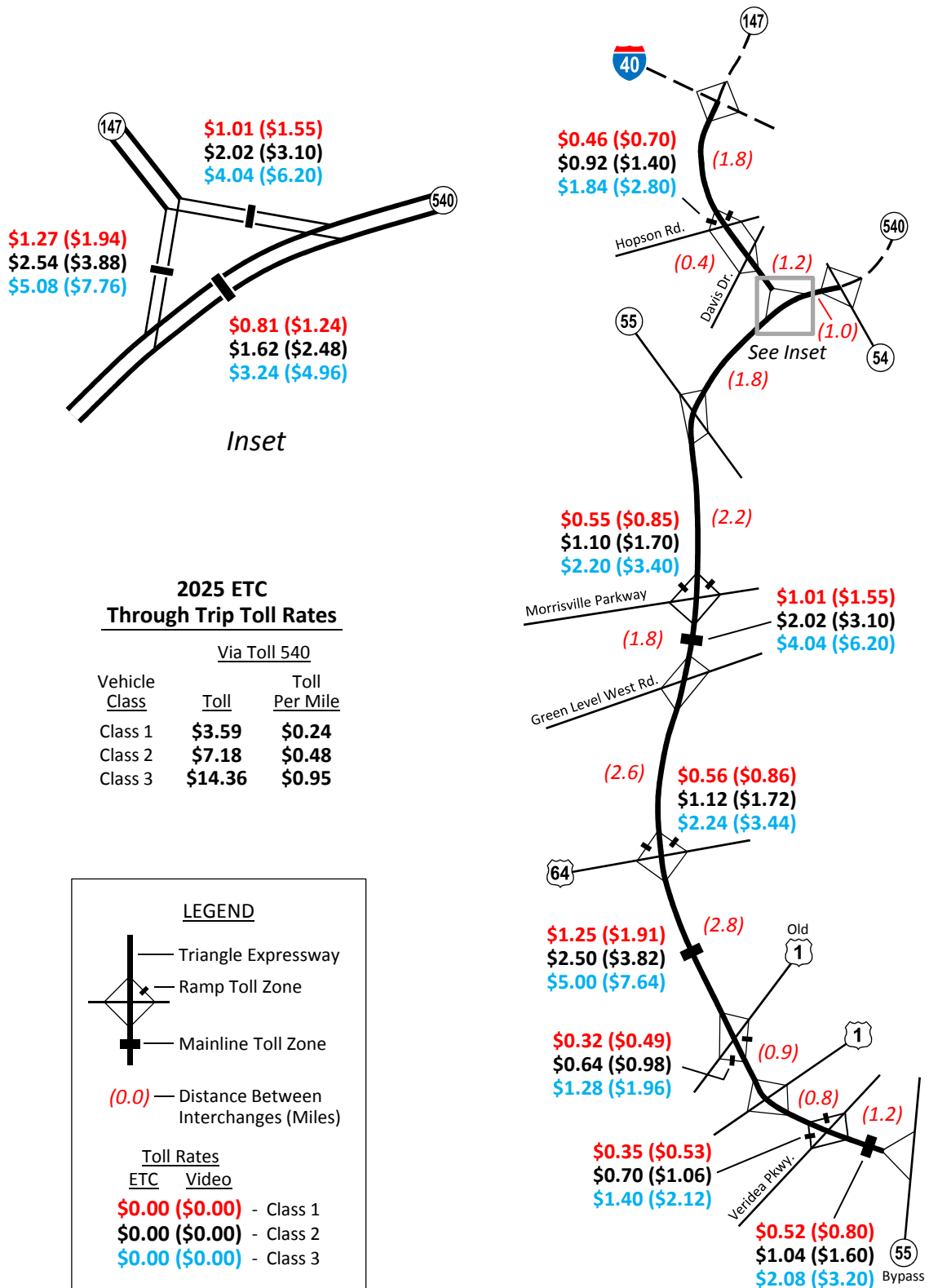
Figure 4.2 graphically displays the 2025 ETC and video toll rates by tolling zone for Class 1, Class 2 and Class 3 vehicles. At 2025 levels, the ETC toll for a full-length trip through all four mainline tolling zones on the Toll 540 portion of the Triangle Expressway will total \$3.59 for Class 1 vehicles, \$7.18 for Class 2 vehicles and \$14.36 for Class 3 vehicles. This results in per-mile toll rates for Class 1, Class 2 and Class 3 vehicles of \$0.24, \$0.48 and \$0.95, respectively. The through trip on the Toll 540 portion of the Triangle Expressway is approximately 15.1 miles.

4.4.2 Complete 540 Toll Rate Schedule

Table 4.3 shows the assumed Complete 540 Class 1 ETC and video toll rates, by tolling zone, from 2025 through 2055. It was assumed that each mainline section of Complete 540 will be tolled on a per-mile basis, and the per-mile toll rates would equal the through-trip per-mile rate on the Triangle Expressway for any given year. The through-trip per-mile toll rates on the Toll 540 portion of the Triangle Expressway are shown in **Table 4.4** for 2016, 2025, 2030 and 2040. Toll rates on Complete 540 are assumed to increase annually at a growth rate similar to the annual increases on the Triangle Expressway.

Calendar Year	Through Trip Toll	Distance (miles)	Per-Mile Toll Rate
2016	\$ 2.70	15.10	\$ 0.179
2025	3.59	15.10	0.238
2030	4.04	15.10	0.268
2040	5.35	15.10	0.354

Toll rates on Complete 540 maintain the same relationships between vehicle classes and payment methods as those utilized on the Triangle Expressway. **Figure 4.3** presents the 2025 ETC and video toll rates at each tolling zone for by vehicle class and payment method.



**TRIANGLE EXPRESSWAY:
2025 ETC AND VIDEO TOLL RATES**



LEGEND

- Proposed Complete 540
- Mainline Toll Zone
- (0.0) Distance Between Interchanges (Miles)

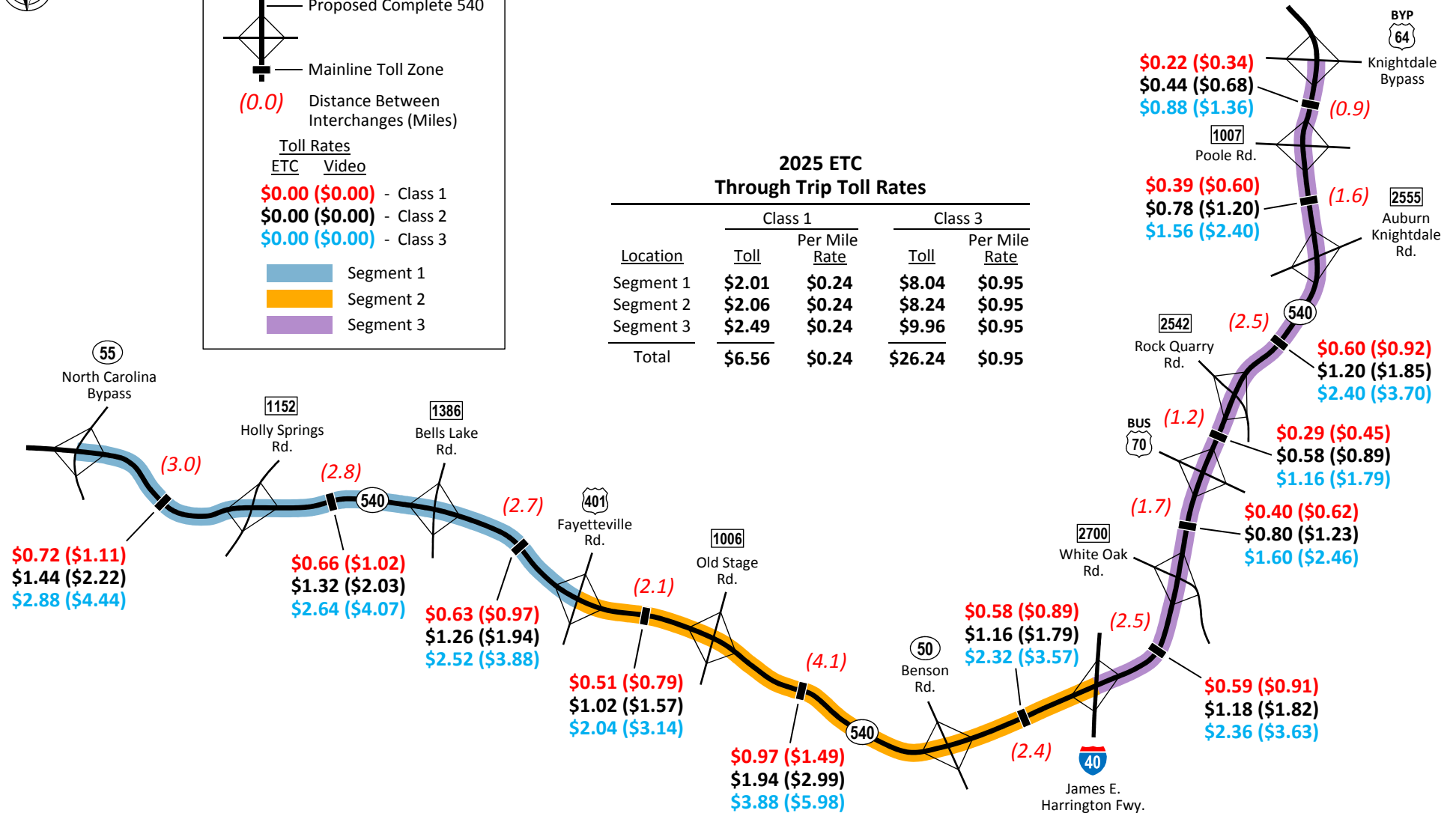
Toll Rates

ETC	Video	Class
\$0.00	(\$0.00)	Class 1
\$0.00	(\$0.00)	Class 2
\$0.00	(\$0.00)	Class 3

- Segment 1
- Segment 2
- Segment 3

2025 ETC Through Trip Toll Rates

Location	Class 1		Class 3	
	Toll	Per Mile Rate	Toll	Per Mile Rate
Segment 1	\$2.01	\$0.24	\$8.04	\$0.95
Segment 2	\$2.06	\$0.24	\$8.24	\$0.95
Segment 3	\$2.49	\$0.24	\$9.96	\$0.95
Total	\$6.56	\$0.24	\$26.24	\$0.95



4.4.3 Comparison of Through-Trip Toll Rates

A comparison of the assumed through-trip toll rates is provided in **Table 4.5** for the Triangle Expressway and each of the three Complete 540 segments. The total through-trip toll rate on Complete 540 would be the total of segments 1, 2 and 3. Toll rates are provided for each vehicle class and method of payment, at 2017, 2025, 2030 and 2040 levels.

Calendar Year	Toll Class	Triangle Expressway (Toll 540)	Complete 540					
			Segment 1		Segment 2		Segment 3	
			ETC	Video	ETC	Video	ETC	Video
2017 (1)	Class 1	\$ 2.78	\$ -	\$ 1.57	\$ 2.41	\$ 1.60	\$ 2.46	\$ 1.94
	Class 2	\$ 5.56	\$ 3.14	\$ 4.83	\$ 3.20	\$ 4.93	\$ 3.88	\$ 5.97
	Class 3	\$ 11.12	\$ 6.28	\$ 9.67	\$ 6.40	\$ 9.85	\$ 7.76	\$11.96
2025	Class 1	\$ 3.59	\$ -	\$ 2.01	\$ 3.10	\$ 2.06	\$ 3.17	\$ 2.49
	Class 2	\$ 7.18	\$ 4.02	\$ 6.19	\$ 4.12	\$ 6.35	\$ 4.98	\$ 7.67
	Class 3	\$ 14.36	\$ 8.04	\$12.39	\$ 8.24	\$12.69	\$ 9.96	\$15.34
2030	Class 1	\$ 4.17	\$ -	\$ 2.34	\$ 3.60	\$ 2.38	\$ 3.66	\$ 2.89
	Class 2	\$ 8.34	\$ 4.68	\$ 7.21	\$ 4.76	\$ 7.33	\$ 5.78	\$ 8.91
	Class 3	\$ 16.68	\$ 9.36	\$14.41	\$ 9.52	\$14.66	\$11.56	\$17.79
2040	Class 1	\$ 5.35	\$ -	\$ 3.04	\$ 4.68	\$ 3.10	\$ 4.78	\$ 3.76
	Class 2	\$ 10.70	\$ 6.08	\$ 9.37	\$ 6.20	\$ 9.55	\$ 7.52	\$11.59
	Class 3	\$ 21.40	\$12.16	\$18.72	\$12.40	\$19.09	\$15.04	\$23.16

4.5 Other Inputs

This section describes key inputs to the model that influence the traffic and toll revenue analysis process.

4.5.1 ETC Market Share

The assumed future market share of ETC and video transactions is an important input into the traffic demand model. ETC transactions are at less “risk” of non-payment compared to video transactions, which are more prone to “leakage” or non-payment for a variety of reasons. **Table 4.6** presents the systemwide ETC market share targets for the Triangle Expressway and Complete 540. The 2016 ETC market share target of 58.3% is based on actual experience on the Triangle Expressway. As seen in Table 2.3, the ETC market share on the Triangle Expressway has not appreciably increased since 2013, so a minimal increase in ETC market share was assumed for each future year. As shown in Table 4.6, the resulting ETC market shares from the model output align closely with the targets.

Table 4.6
Systemwide ETC Targeted Market Share and Model Output

Model Year	Target	Model Output			
		Scenario 1	Scenario 2	Scenario 3	Scenario 4
2016	58.3% (1)	59.5%	59.5%	59.5%	59.5%
2019	58.8%	58.9%	58.9%	58.9%	58.9%
2025	60.0%	61.2%	61.0%	61.2%	61.2%
2030	61.0%	62.2%	62.1%	62.3%	62.3%
2040	63.2%	64.3%	64.2%	64.3%	64.3%

(1) The target is based on actual ETC market share on the Triangle Expressway.

4.5.2 Motorist Value-of-Time and Vehicle Operating Cost

Assumptions for motorist value of time (VOT) and vehicle operating cost (VOC) used in this study are presented in **Table 4.7**.

Table 4.7
**Passenger Car Value of Time and
Vehicle Operating Cost Assumptions**
(values in U.S. \$/minute)

Model Year	Value of Time		Vehicle Operating Cost
	Peak Period	Off-Peak Period	
2016	\$ 0.279	\$ 0.233	\$ 0.172
2025	\$ 0.364	\$ 0.304	\$ 0.205
2030	\$ 0.422	\$ 0.352	\$ 0.226
2040	\$ 0.567	\$ 0.474	\$ 0.276

Notes:

Inflation assumed at 2.0 percent per year.

VOT was inflated by 3.0 percent per year to account for real income growth.

Estimates for VOT were based on stated preference surveys conducted as part of the **2009 Comprehensive Report**. VOT from those surveys was inflated to 2016 and future-year levels at 3.0 percent per year for use in the toll diversion model. Inflation was assumed to average 2.0 percent per year. The difference between forecast VOT and forecast inflation represents expected real income growth over the forecast period. VOT was also differentiated for peak and off-peak travel

periods. VOT at 2016 levels was assumed to be \$0.279 per minute (\$16.74/hr.) during peak travel periods and \$0.233 per minute (\$13.98/hr.) during off-peak travel periods. VOT at 2030 levels was assumed to increase to \$0.422 per minute (\$25.32/hr.) during peak travel periods and \$0.352 per minute (\$21.12/hr.) during off-peak travel periods.

Vehicle operating costs (VOC) account for the wear and tear on a vehicle, including maintenance costs, tire replacement, and oil and fuel. A passenger-car operating cost of \$0.172 per mile was estimated for 2016 based on the following data:

- The average cost of gasoline in the Lower Atlantic states provided by the Energy Information Administration.
- The average cost of tires and maintenance by passenger car vehicle type provided in the *2015 Your Driving Costs* report published by AAA.
- The passenger-car vehicle type distribution for the State of North Carolina published in the *2014 National Automobile Dealers Association (NADA) Annual Report*.

Depreciation and insurance are not included in the operating cost.

By 2030, the average passenger-car vehicle operating cost is estimated to total \$0.226 per mile. Operating costs for future years were developed by inflating 2016 VOC by 2.0 percent per year.

Commercial-vehicle operating costs are much more difficult to calculate due to the variation in truck sizes, and the types and availability of corporate fleet information. For this study, the vehicle operating cost assumed for commercial vehicle trips was approximately three times greater than passenger cars in 2016. This differential increases over time since anticipated fuel efficiency improvements for passenger vehicles are not assumed for commercial vehicles. By 2030, it was assumed that commercial vehicle operating costs were approximately four times greater than passenger cars on a per-mile basis.

4.6 Traffic and Revenue Forecasts by Scenario

The following summarizes the steps in developing traffic and revenue forecasts from the model output. The model output is first reviewed for reasonableness, and adjustments may be made at spot locations. Once the model output was validated, the calendar-year average annual weekday traffic volumes (AAWDT) were converted into annual toll transactions, utilizing an annualization factor of 308. The annualization factor accounts for the number of non-holiday weekday and weekend days; the number of holidays; and the amount of traffic that occurs on those days. The conversion accounts for lower traffic volumes on weekend days and holidays compared to weekday traffic demand. An annualization factor of 308 was used, which means that the annual transactions are equivalent to 308 days of weekday tolled traffic.

The annualization factor was based on one complete year of 2016 daily traffic data from all tolled locations on the Triangle Expressway. During 2016 there were 250 non-holiday weekdays, 104 non-holiday weekend days, and 12 holidays. The average weekend day traffic was 50.4 percent of the average weekday traffic on the Triangle Expressway.

Class 1 toll transactions for each toll zone and by ETC and video, are multiplied by their corresponding toll rates to arrive at the annual toll revenue for each tolling zone. Similarly, the combined Class 2 and 3 toll transactions, are multiplied by an average weighted toll for the two classes to arrive at the annual toll revenue for each tolling zone.

Annual transactions and toll revenue were dampened to reflect “ramp-up” during the initial 36 months of a new tolling zone. With new toll facilities, or extensions to existing facilities, it often takes time for motorists to learn about the improvements and change their travel patterns, particularly for motorists who may use the road infrequently or live far from the road. It also accounts for the time it takes motorists to learn about and feel comfortable with the toll collection methods, particularly if there aren’t existing toll roads in the area. The following ramp-up factors were applied to the tolled traffic:

- 0.610 ramp-up factor for months 1 through 12;
- 0.814 ramp-up factor for months 13 through 24; and
- 0.945 ramp-up factor for months 25 through 36.

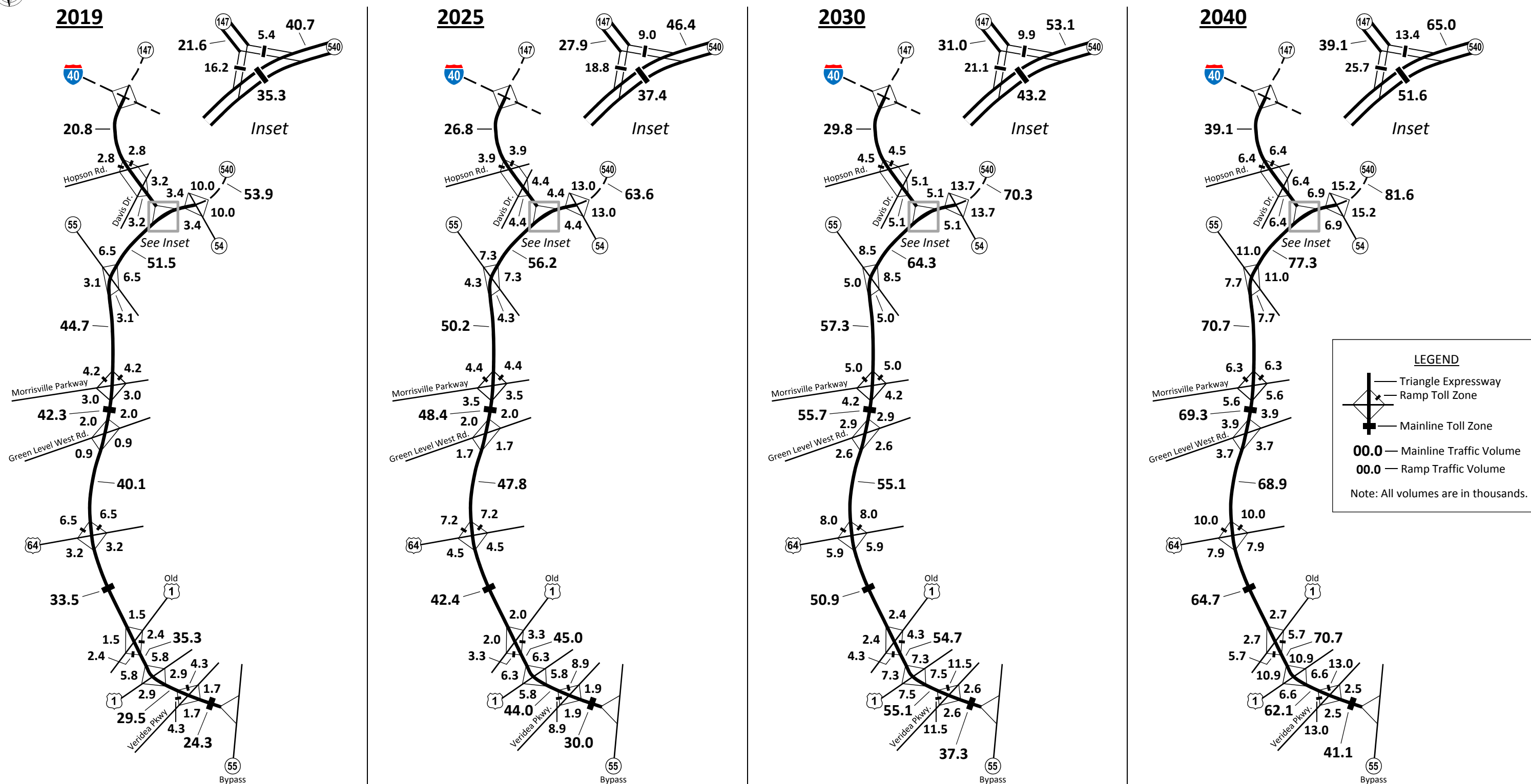
Calendar-year transaction and toll revenue forecasts were divided in half and allocated to the appropriate fiscal year, which is assumed to run from July 1 of one calendar year to June 30 of the following calendar year. Traffic volumes for non-modeled years were developed by interpolating between adjacent modeled-year traffic volumes. Toll transactions for the years beyond the available model years were developed by assuming an annual increase in traffic based on decreasing the prior trend line.

For the purposes of this study, revenue leakage due to unreadable or uncollectible ETC or video transactions, or any transactions that cannot be processed and payment collected, were assumed to be offset by fee revenue as observed in actual experience on the Triangle Expressway. All toll revenue estimates in this report are **adjusted** toll revenue, accounting for decreased toll revenue associated with non-payment/non-recoverable BBM transactions.

4.6.1 Triangle Expressway – Scenario 1.0

This section presents annual toll transactions and adjusted toll revenue forecasts for Scenario 1 from FY 2017 through FY 2055. Scenario 1 accounts for all existing Triangle Expressway tolling zones, including the recently opened interchange with Veridea Parkway, and the planned interchange with Morrisville Parkway, assumed to open in 2019. Scenario 1 represents an update to the existing Triangle Expressway traffic and toll revenue forecast and will serve as a point of comparison for the remaining scenarios presented later in this chapter.

Estimates of weekday mainline and ramp traffic volumes in 2019, 2025, 2030 and 2040 are shown in **Figure 4.4**. As can be seen in the figure, weekday mainline traffic volumes increase steadily over time throughout the corridor. The traffic volumes shown in the figure do not include any downward “ramp-up” adjustment for the Veridea or the Morrisville Parkway interchanges in 2019, which is incorporated in the annual traffic forecasts. The highest rates of growth are expected in the southern half of the corridor. AAWDT volumes at the two mainline toll zones located north of NC 55 Bypass and south of US 64 are forecast to grow at an average annual rate of 4.0 and 3.9 percent, respectively, between 2019 and 2030. Further to the north, AAWDT volumes at the two mainline



**SCENARIO 1: TRIANGLE EXPRESSWAY
AVERAGE WEEKDAY TRAFFIC FORECASTS - 2019, 2025, 2030, 2040**

4.6.2 Complete 540 – Scenarios 2.0, 3.0 and 4.0

This section presents systemwide annual toll transactions and adjusted toll revenue forecasts for Scenarios 2, 3 and 4 from FY 2017 through FY 2055. Scenarios 2, 3 and 4 represent the various phasing options for Complete 540.

Estimates of Complete 540 mainline AAWDT volumes at 2025 levels are shown for Scenarios 2 and 3 in **Figure 4.5**. Estimated Segment 1 mainline volumes, between NC 55 and US 401, range from 18,800 to 19,500 vehicles in 2025 under Scenario 2. Under Scenario 3, average weekday traffic volumes on Segment 1 range from 21,400 to 26,400 vehicles. Segment 2 mainline AAWDTs range from a high of 27,000 east of US 401 to a low of 15,100 between Old Stage Road and NC 50 9Benson Road). Segment 3 is not operational in 2025 under any scenario.

Estimates of Complete 540 mainline AAWDT volumes at 2030 levels are shown for Scenarios 2, 3 and 4 in **Figure 4.6**. Under Scenario 2, estimated Segment 1 mainline volumes range from 24,100 to 25,800 vehicles. Under Scenario 3, average weekday traffic volumes on Segment 1 increase, ranging from 29,100 to 35,000 vehicles. Segment 1 volumes further increase under Scenario 4, ranging from 33,000 to 38,500 vehicles. Segment 3 positively impacts traffic volumes on Segment 2, increasing traffic on mainline sections from 2,600 to 5,600 per weekday. Segment 3 AAWDT volumes range from 26,000 vehicles east of I-40 to 44,700 vehicles south of the Knightdale Bypass.

Estimates of Complete 540 mainline AAWDT volumes at 2040 levels are shown for Scenarios 2, 3 and 4 in **Figure 4.7**. Segment 2 adds 4,900 to 13,500 additional vehicles per weekday per mainline section on Segment 1. The addition of Segment 3 adds about 4,300 vehicles per weekday to Segment 1 mainline sections, and from 2,500 to 6,500 vehicles per weekday on Segment 2 mainline sections.

To put these weekday traffic estimates in context of total demand in the corridor, **Figure 4.8** presents 2030 Complete 540 mainline AAWDTs at three locations as a percent of total traffic traveling across screenlines that include nearby toll-free alternative routes. At the mainline tolling zone south of US 70 Business, traffic on Complete 540 constitutes 13 percent of average weekday traffic crossing Screenline 2. Traffic on I-40 comprises 72 percent of average weekday traffic crossing Screenline 2. On Screenline 3, Complete 540 traffic totals 26 percent of total traffic traveling east-west across the screenline. On Segment 1, Complete 540 traffic totals 39 percent of traffic traveling east-west across Screenline 5.

Figure 4.9 presents 2030 weekday traffic impacts at toll locations on the Triangle expressway due to Complete 540 Scenarios 2, 3 and 4. The greatest impacts can be seen at the southern-most mainline west of NC 55 Bypass with positive impacts of 12,900 under Scenario 2, 16,200 under Scenario 3, and 15,800 under Scenario 4. These impacts diminish further north with mainline impacts south of US 64 estimated at 2,900 under Scenario 2, 4,600 under Scenario 3, and 4,200 under Scenario 4. At the Toll 540 mainline toll location at Toll 147, estimated impacts are 600 vehicles or fewer under Scenarios 2, 3 and 4. Traffic impacts under Scenario 3 are either equal to or slightly greater than traffic impacts under Scenario 4. This is because the opening of Segment 3 (Scenario 4) draws a small amount of traffic off some segment 2 sections, although it adds some traffic at the Toll 540 mainline at Toll 147.



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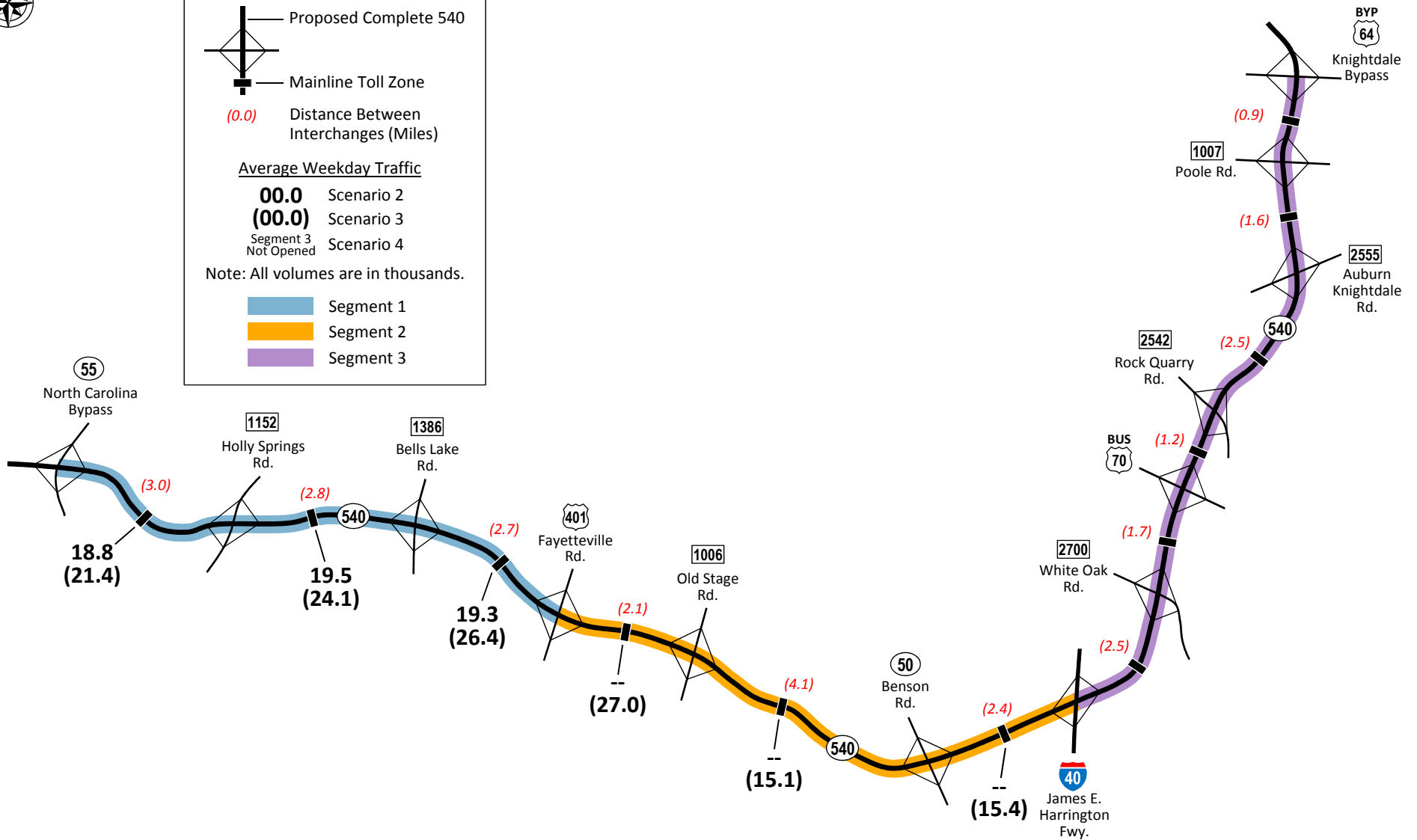
- Proposed Complete 540
- Mainline Toll Zone
- (0.0)* Distance Between Interchanges (Miles)

Average Weekday Traffic

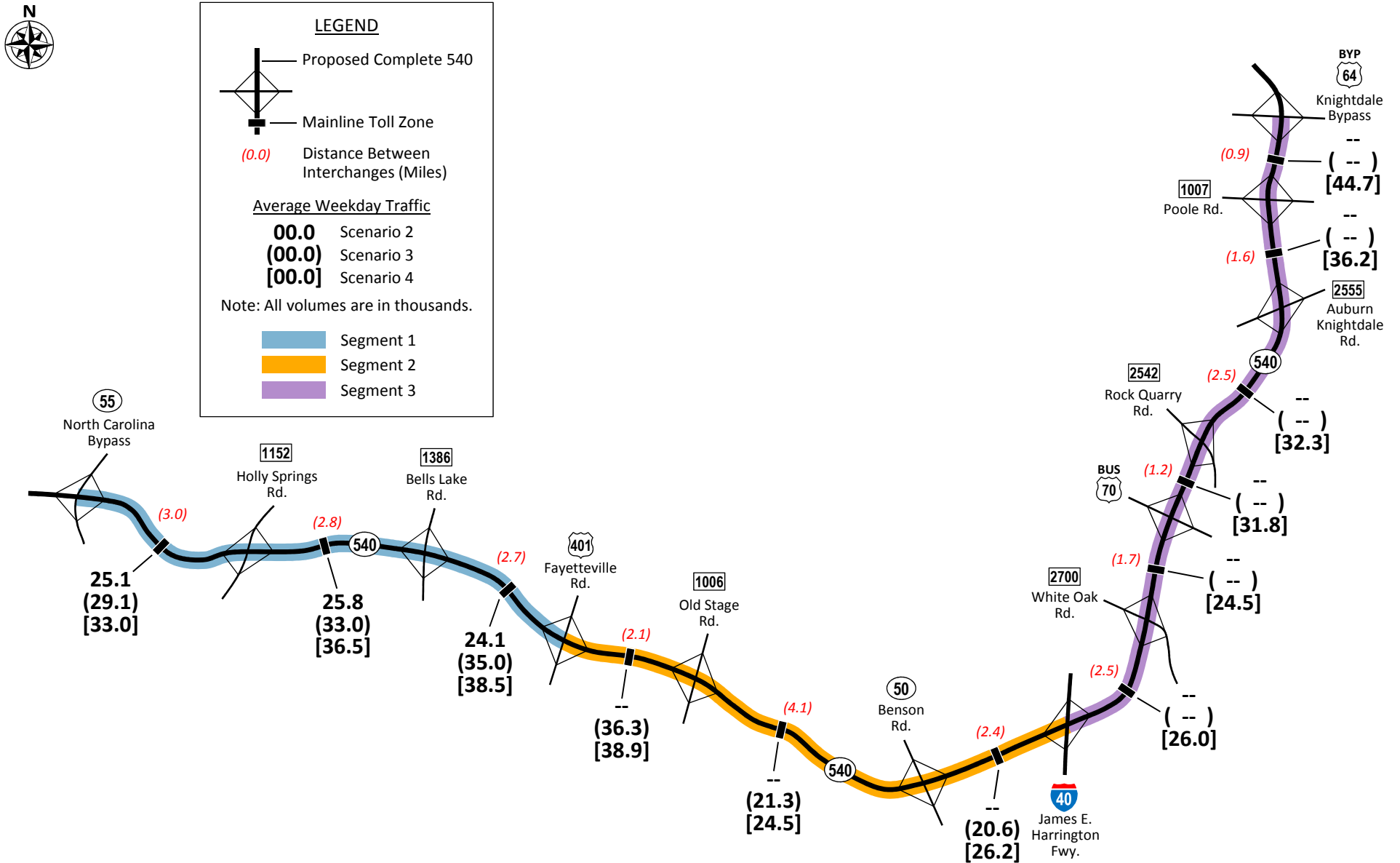
00.0	Scenario 2
(00.0)	Scenario 3
Segment 3 Not Opened	Scenario 4

Note: All volumes are in thousands.

- Segment 1
- Segment 2
- Segment 3



**COMPLETE 540: 2025 AVERAGE WEEKDAY
TRAFFIC BY SCENARIO**



**COMPLETE 540: 2030 AVERAGE WEEKDAY
TRAFFIC BY SCENARIO**



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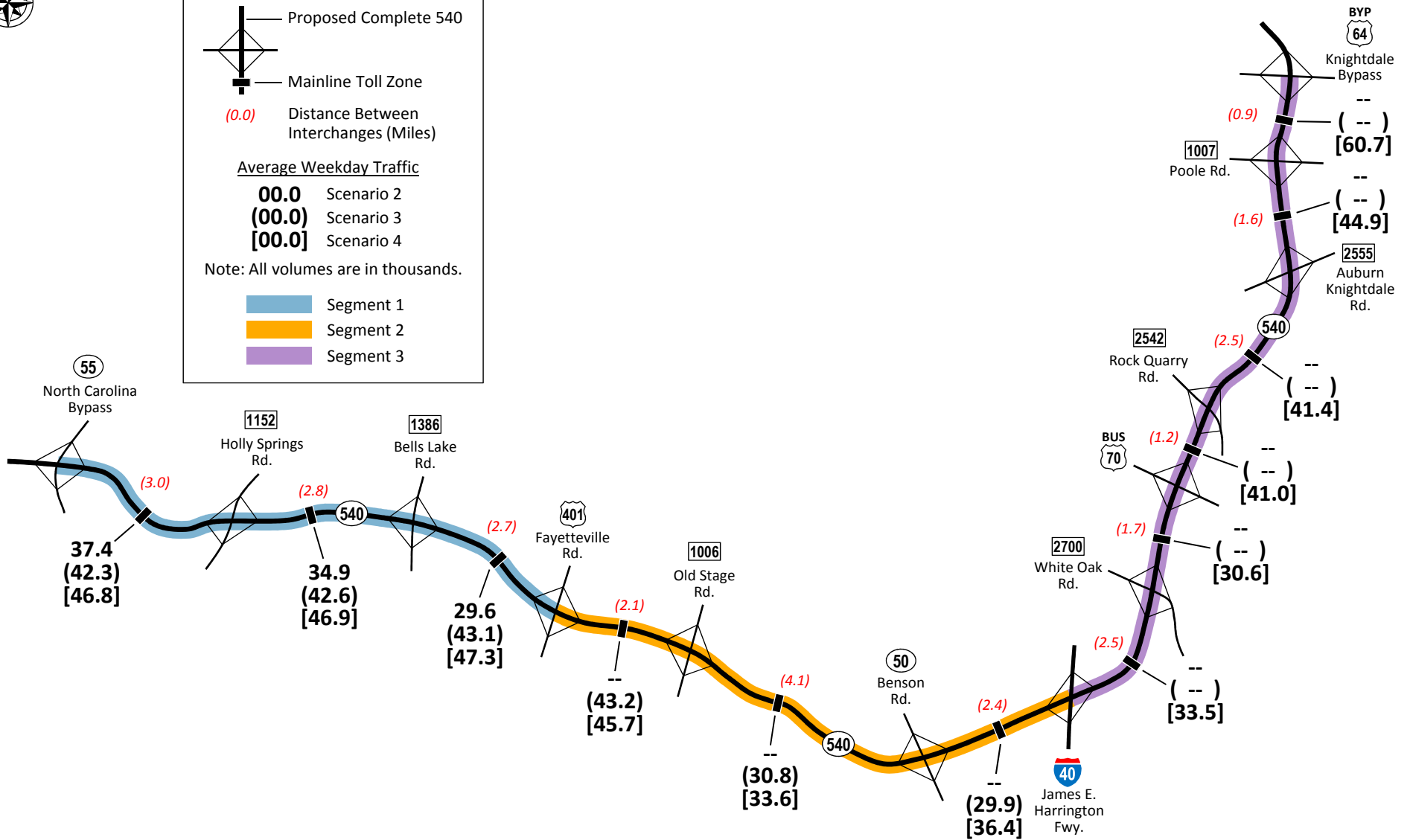
- Proposed Complete 540
- Mainline Toll Zone
- (0.0) Distance Between Interchanges (Miles)

Average Weekday Traffic

00.0	Scenario 2
(00.0)	Scenario 3
[00.0]	Scenario 4

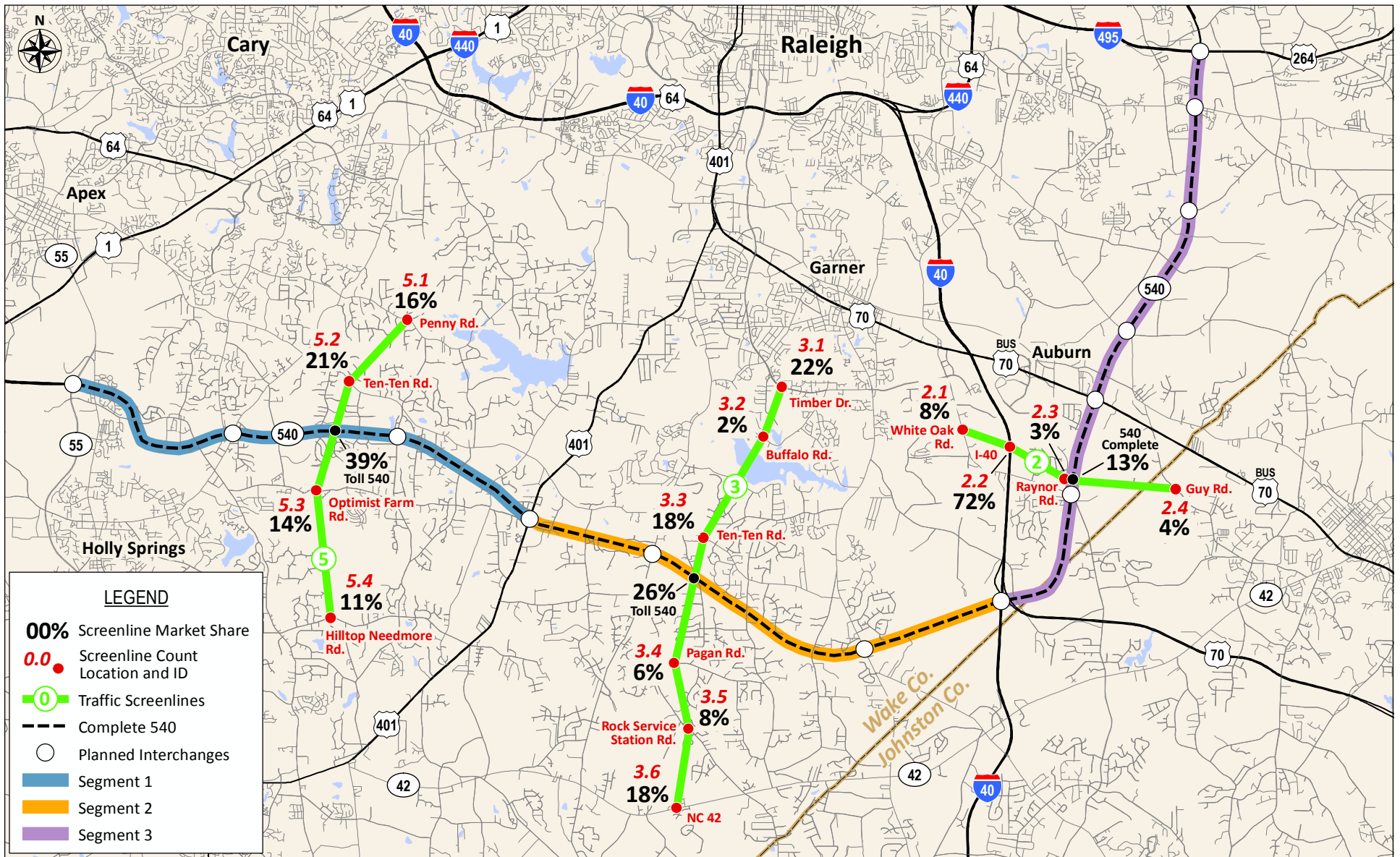
Note: All volumes are in thousands.

- Segment 1
- Segment 2
- Segment 3

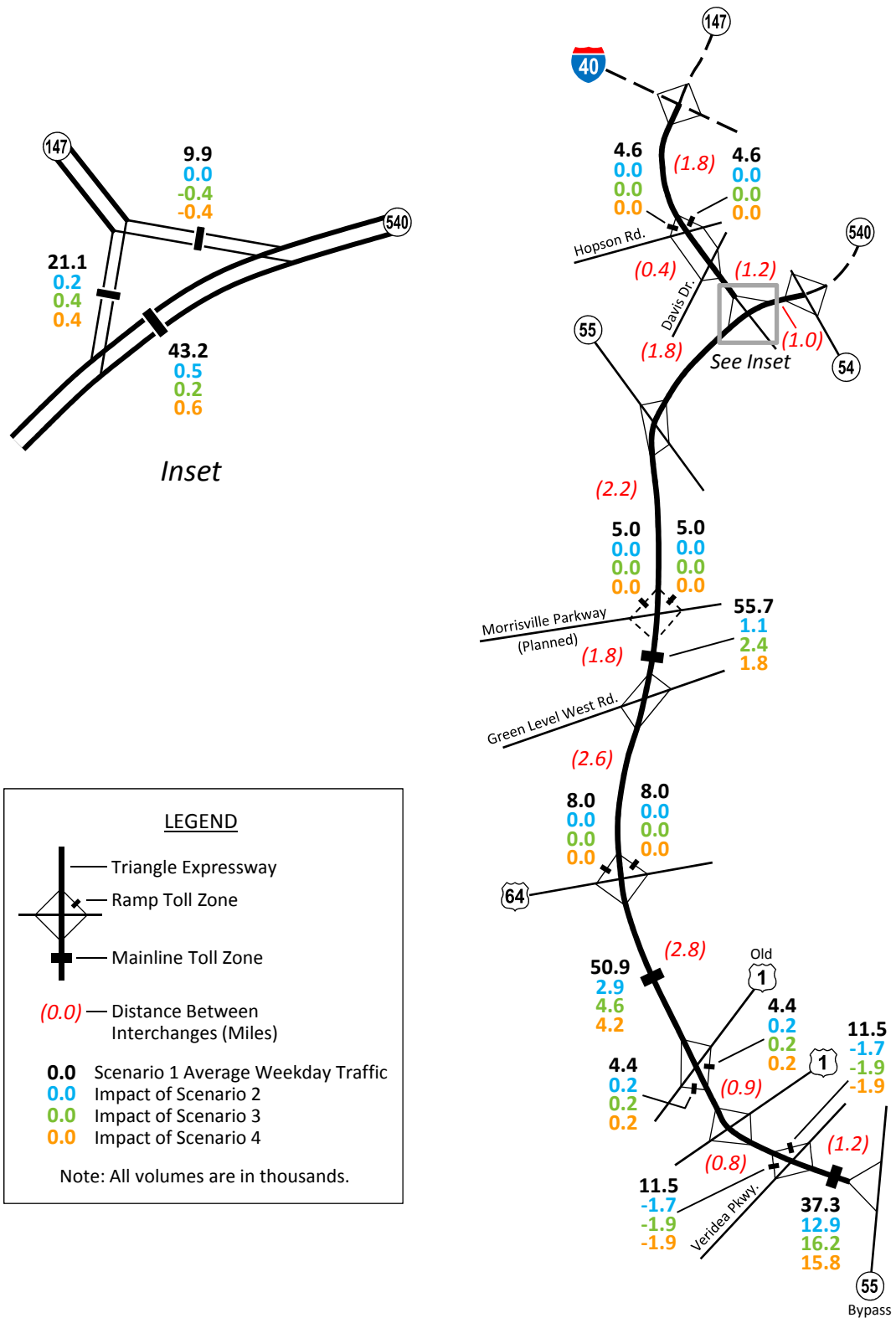


Complete 540 Planning Level Traffic and Revenue Study

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2030 AVERAGE WEEKDAY SCREENLINE MARKET SHARE



Tables 4.10 and 4.11 present annual forecasts for toll transactions and adjusted toll revenue for Scenario 2. Scenario 3 annual transaction and adjusted toll revenue forecasts can be seen in **Tables**

Fiscal Year	Toll Class 1				Toll Classes 2 & 3				All Toll Classes				
	ETC	Video	Total	% ETC	ETC	Video	Total	% ETC	ETC	Video	Total	% ETC	% Trucks
2017 (1)	27,454	18,516	45,970	59.7	963	1,013	1,976	48.7	28,417	19,529	47,946	59.3	4.1
2018 (2)	29,866	20,349	50,214	59.5	1,034	1,083	2,116	48.8	30,900	21,431	52,331	59.0	4.0
2019 (2)(3)	32,186	22,017	54,203	59.4	1,071	1,113	2,184	49.0	33,257	23,130	56,387	59.0	3.9
2020 (2)	34,586	23,530	58,116	59.5	1,115	1,143	2,259	49.4	35,701	24,674	60,375	59.1	3.7
2021 (2)	36,478	24,439	60,917	59.9	1,160	1,166	2,326	49.9	37,637	25,605	63,243	59.5	3.7
2022	38,199	25,190	63,389	60.3	1,202	1,188	2,390	50.3	39,402	26,377	65,779	59.9	3.6
2023	39,840	25,858	65,698	60.6	1,246	1,209	2,455	50.7	41,086	27,067	68,153	60.3	3.6
2024	41,496	26,514	68,010	61.0	1,291	1,232	2,522	51.2	42,787	27,745	70,533	60.7	3.6
2025 (2)(4)	47,022	29,681	76,704	61.3	1,388	1,291	2,679	51.8	48,410	30,972	79,383	61.0	3.4
2026 (2)	54,096	33,898	87,994	61.5	1,500	1,362	2,861	52.4	55,596	35,260	90,856	61.2	3.1
2027 (2)	58,607	36,456	95,063	61.7	1,572	1,404	2,976	52.8	60,179	37,860	98,039	61.4	3.0
2028	62,432	38,520	100,952	61.8	1,635	1,441	3,076	53.2	64,067	39,961	104,028	61.6	3.0
2029	65,536	40,087	105,622	62.0	1,689	1,471	3,160	53.5	67,225	41,557	108,782	61.8	2.9
2030	68,382	41,459	109,840	62.3	1,741	1,498	3,239	53.7	70,122	42,957	113,079	62.0	2.9
2031	70,797	42,544	113,341	62.5	1,787	1,521	3,308	54.0	72,584	44,065	116,649	62.2	2.8
2032	72,745	43,324	116,069	62.7	1,827	1,538	3,366	54.3	74,573	44,862	119,435	62.4	2.8
2033	74,749	44,120	118,870	62.9	1,868	1,556	3,425	54.6	76,618	45,676	122,294	62.7	2.8
2034	76,811	44,933	121,744	63.1	1,911	1,574	3,485	54.8	78,722	46,508	125,230	62.9	2.8
2035	78,932	45,764	124,696	63.3	1,954	1,593	3,548	55.1	80,887	47,357	128,244	63.1	2.8
2036	81,115	46,612	127,726	63.5	1,999	1,613	3,612	55.3	83,114	48,224	131,338	63.3	2.8
2037	83,360	47,478	130,838	63.7	2,045	1,633	3,678	55.6	85,404	49,111	134,515	63.5	2.7
2038	85,670	48,363	134,032	63.9	2,092	1,653	3,745	55.9	87,762	50,016	137,777	63.7	2.7
2039	88,046	49,266	137,312	64.1	2,142	1,673	3,815	56.1	90,188	50,939	141,127	63.9	2.7
2040 (5)	90,492	50,188	140,680	64.3	2,192	1,694	3,886	56.4	92,684	51,882	144,566	64.1	2.7
2041	92,321	50,995	143,316	64.4	2,230	1,713	3,943	56.6	94,552	52,707	147,259	64.2	2.7
2042	93,508	51,681	145,189	64.4	2,256	1,729	3,985	56.6	95,764	53,410	149,174	64.2	2.7
2043	94,710	52,375	147,085	64.4	2,282	1,746	4,028	56.7	96,992	54,121	151,113	64.2	2.7
2044	95,928	53,078	149,006	64.4	2,308	1,763	4,071	56.7	98,236	54,841	153,077	64.2	2.7
2045	97,162	53,791	150,953	64.4	2,335	1,780	4,115	56.7	99,497	55,571	155,067	64.2	2.7
2046	98,364	54,484	152,848	64.4	2,361	1,797	4,157	56.8	100,724	56,281	157,005	64.2	2.6
2047	99,532	55,159	154,691	64.3	2,386	1,813	4,199	56.8	101,918	56,971	158,889	64.1	2.6
2048	100,715	55,841	156,555	64.3	2,411	1,829	4,241	56.9	103,126	57,670	160,796	64.1	2.6
2049	101,911	56,531	158,442	64.3	2,437	1,846	4,283	56.9	104,349	58,377	162,726	64.1	2.6
2050	103,123	57,229	160,352	64.3	2,463	1,863	4,326	56.9	105,586	59,092	164,678	64.1	2.6
2051	104,297	57,907	162,204	64.3	2,489	1,879	4,368	57.0	106,786	59,786	166,572	64.1	2.6
2052	105,434	58,562	163,996	64.3	2,513	1,895	4,408	57.0	107,947	60,457	168,404	64.1	2.6
2053	106,583	59,224	165,807	64.3	2,538	1,911	4,449	57.0	109,121	61,135	170,256	64.1	2.6
2054	107,745	59,894	167,639	64.3	2,563	1,927	4,490	57.1	110,309	61,821	172,129	64.1	2.6
2055	108,920	60,570	169,491	64.3	2,588	1,943	4,532	57.1	111,509	62,514	174,023	64.1	2.6

(1) The Triangle Expressway interchange with Veridea Parkway is assumed to open January 1, 2017.
(2) Ramp up is applied to the first three years of transaction and revenue impacts associated with new toll zones.
(3) The Triangle Expressway interchange with Morrisville Parkway is assumed to open January 1, 2019.
(4) Complete 540 from NC 55 Bypass to US 401 (Segment 1) is assumed to open January 1, 2025.
(5) Calendar year 2040 represents the last model year.

Table 4.11
Scenario 2: Annual Adjusted Toll Revenue Forecast by Class and Payment Type
Triangle Expressway Plus Complete 540 through U.S. 401
 (all revenue in thousands of \$)

Fiscal Year	Toll Class 1				Toll Classes 2 & 3				All Toll Classes				
	ETC	Video	Total	% ETC	ETC	Video	Total	% ETC	ETC	Video	Total	% ETC	% Trucks
2017 (1)	\$ 18,782	\$ 19,652	\$ 38,434	48.9	\$ 2,252	\$ 3,658	\$ 5,911	38.1	\$ 21,034	\$ 23,310	\$ 44,344	47.4	13.3
2018 (2)	20,868	22,048	42,916	48.6	2,469	4,004	6,473	38.1	23,337	26,052	49,389	47.3	13.1
2019 (2)(3)	23,046	24,424	47,469	48.5	2,629	4,236	6,864	38.3	25,674	28,660	54,334	47.3	12.6
2020 (2)	25,349	26,689	52,038	48.7	2,809	4,469	7,278	38.6	28,157	31,159	59,316	47.5	12.3
2021 (2)	27,484	28,470	55,954	49.1	2,998	4,685	7,683	39.0	30,482	33,155	63,637	47.9	12.1
2022	29,560	30,145	59,706	49.5	3,189	4,896	8,085	39.4	32,749	35,041	67,790	48.3	11.9
2023	31,604	31,765	63,369	49.9	3,379	5,108	8,487	39.8	34,983	36,873	71,856	48.7	11.8
2024	33,842	33,500	67,342	50.3	3,588	5,338	8,927	40.2	37,431	38,838	76,269	49.1	11.7
2025 (2)(4)	38,813	37,930	76,744	50.6	3,923	5,703	9,626	40.8	42,737	43,633	86,370	49.5	11.1
2026 (2)	45,040	43,666	88,706	50.8	4,301	6,121	10,422	41.3	49,341	49,786	99,127	49.8	10.5
2027 (2)	49,899	47,969	97,867	51.0	4,617	6,470	11,087	41.6	54,516	54,438	108,954	50.0	10.2
2028	54,376	51,880	106,255	51.2	4,916	6,809	11,725	41.9	59,291	58,689	117,980	50.3	9.9
2029	58,526	55,415	113,941	51.4	5,203	7,135	12,338	42.2	63,729	62,549	126,278	50.5	9.8
2030	62,800	58,937	121,737	51.6	5,509	7,470	12,979	42.4	68,309	66,407	134,716	50.7	9.6
2031	66,957	62,236	129,194	51.8	5,821	7,805	13,626	42.7	72,779	70,041	142,820	51.0	9.5
2032	70,885	65,288	136,174	52.1	6,135	8,133	14,268	43.0	77,020	73,422	150,442	51.2	9.5
2033	74,999	68,480	143,479	52.3	6,463	8,477	14,940	43.3	81,462	76,956	158,419	51.4	9.4
2034	79,360	71,806	151,166	52.5	6,809	8,836	15,645	43.5	86,169	80,642	166,810	51.7	9.4
2035	83,979	75,318	159,296	52.7	7,175	9,212	16,387	43.8	91,153	84,530	175,683	51.9	9.3
2036	88,751	78,845	167,596	53.0	7,550	9,588	17,139	44.1	96,302	88,433	184,735	52.1	9.3
2037	93,351	82,185	175,536	53.2	7,906	9,934	17,840	44.3	101,257	92,118	193,376	52.4	9.2
2038	97,856	85,412	183,268	53.4	8,249	10,253	18,502	44.6	106,105	95,666	201,770	52.6	9.2
2039	102,658	88,737	191,396	53.6	8,618	10,585	19,203	44.9	111,276	99,323	210,599	52.8	9.1
2040 (5)	107,774	92,310	200,083	53.9	9,010	10,938	19,948	45.2	116,784	103,247	220,032	53.1	9.1
2041	111,897	95,462	207,359	54.0	9,329	11,251	20,580	45.3	121,226	106,713	227,939	53.2	9.0
2042	114,870	97,969	212,840	54.0	9,559	11,498	21,057	45.4	124,430	109,467	233,897	53.2	9.0
2043	117,737	100,310	218,046	54.0	9,778	11,720	21,497	45.5	127,515	112,029	239,544	53.2	9.0
2044	120,593	102,655	223,248	54.0	9,996	11,943	21,939	45.6	130,589	114,598	245,187	53.3	8.9
2045	123,571	105,122	228,693	54.0	10,225	12,172	22,397	45.7	133,796	117,294	251,090	53.3	8.9
2046	126,542	107,549	234,091	54.1	10,456	12,396	22,852	45.8	136,998	119,946	256,943	53.3	8.9
2047	129,474	109,909	239,383	54.1	10,681	12,624	23,305	45.8	140,155	122,532	262,688	53.4	8.9
2048	132,490	112,360	244,850	54.1	10,909	12,855	23,764	45.9	143,399	125,215	268,614	53.4	8.8
2049	135,501	114,840	250,341	54.1	11,139	13,085	24,224	46.0	146,640	127,925	274,565	53.4	8.8
2050	138,593	117,370	255,963	54.1	11,379	13,318	24,697	46.1	149,972	130,689	280,660	53.4	8.8
2051	141,668	119,895	261,563	54.2	11,616	13,553	25,169	46.2	153,284	133,448	286,732	53.5	8.8
2052	144,720	122,395	267,115	54.2	11,847	13,787	25,634	46.2	156,567	136,182	292,749	53.5	8.8
2053	147,882	124,937	272,819	54.2	12,087	14,022	26,109	46.3	159,968	138,959	298,928	53.5	8.7
2054	151,062	127,479	278,541	54.2	12,332	14,263	26,594	46.4	163,394	141,742	305,136	53.5	8.7
2055	154,288	130,102	284,391	54.3	12,578	14,510	27,088	46.4	166,866	144,613	311,479	53.6	8.7

- (1) The Triangle Expressway interchange with Veridea Parkway is assumed to open January 1, 2017.
- (2) Ramp up is applied to the first three years of transaction and revenue impacts associated with new toll zones.
- (3) The Triangle Expressway interchange with Morrisville Parkway is assumed to open January 1, 2019.
- (4) Complete 540 from NC 55 Bypass to US 401 (Segment 1) is assumed to open January 1, 2025.
- (5) Calendar year 2040 represents the last model year.

4.12 and 4.13. Scenario 4 annual transaction and adjusted toll revenue forecasts are shown in Tables 4.14 and 4.15. Further discussion of growth rates and the impacts of various improvements within each of these scenarios is presented in Section 4.7.

Table 4.12
Scenario 3: Annual Transaction Forecast by Class and Payment Type
Triangle Expressway Plus Complete 540 through Interstate 40
(all transactions in thousands)

Fiscal Year	Toll Class 1				Toll Classes 2 & 3				All Toll Classes				
	ETC	Video	Total	% ETC	ETC	Video	Total	% ETC	ETC	Video	Total	% ETC	% Trucks
2017 (1)	27,454	18,516	45,970	59.7	963	1,013	1,976	48.7	28,417	19,529	47,946	59.3	4.1
2018 (2)	29,866	20,349	50,214	59.5	1,034	1,083	2,116	48.8	30,900	21,431	52,331	59.0	4.0
2019 (2)(3)	32,186	22,017	54,203	59.4	1,071	1,113	2,184	49.0	33,257	23,130	56,387	59.0	3.9
2020 (2)	34,586	23,530	58,116	59.5	1,115	1,143	2,259	49.4	35,701	24,674	60,375	59.1	3.7
2021 (2)	36,478	24,439	60,917	59.9	1,160	1,166	2,326	49.9	37,637	25,605	63,243	59.5	3.7
2022	38,199	25,190	63,389	60.3	1,202	1,188	2,390	50.3	39,402	26,377	65,779	59.9	3.6
2023	39,840	25,858	65,698	60.6	1,246	1,209	2,455	50.7	41,086	27,067	68,153	60.3	3.6
2024	41,496	26,514	68,010	61.0	1,291	1,232	2,522	51.2	42,787	27,745	70,533	60.7	3.6
2025 (2)(4)	51,394	32,388	83,782	61.3	1,480	1,351	2,831	52.3	52,874	33,738	86,613	61.0	3.3
2026 (2)	64,723	40,437	105,159	61.5	1,721	1,504	3,225	53.4	66,444	41,941	108,385	61.3	3.0
2027 (2)	72,654	45,013	117,668	61.7	1,860	1,589	3,448	53.9	74,514	46,602	121,116	61.5	2.8
2028	79,069	48,554	127,623	62.0	1,971	1,654	3,625	54.4	81,040	50,208	131,248	61.7	2.8
2029	83,865	51,029	134,893	62.2	2,055	1,700	3,755	54.7	85,919	52,729	138,648	62.0	2.7
2030	88,038	53,072	141,110	62.4	2,126	1,739	3,865	55.0	90,164	54,811	144,975	62.2	2.7
2031	91,417	54,621	146,038	62.6	2,188	1,770	3,957	55.3	93,605	56,390	149,995	62.4	2.6
2032	93,928	55,640	149,568	62.8	2,238	1,793	4,031	55.5	96,166	57,433	153,599	62.6	2.6
2033	96,510	56,681	153,191	63.0	2,291	1,816	4,107	55.8	98,801	58,497	157,298	62.8	2.6
2034	99,168	57,745	156,913	63.2	2,344	1,840	4,184	56.0	101,512	59,585	161,097	63.0	2.6
2035	101,902	58,832	160,734	63.4	2,399	1,865	4,264	56.3	104,301	60,697	164,998	63.2	2.6
2036	104,716	59,943	164,659	63.6	2,455	1,890	4,345	56.5	107,171	61,832	169,004	63.4	2.6
2037	107,612	61,077	168,689	63.8	2,514	1,915	4,429	56.8	110,126	62,992	173,118	63.6	2.6
2038	110,593	62,235	172,828	64.0	2,574	1,941	4,515	57.0	113,167	64,176	177,344	63.8	2.5
2039	113,661	63,418	177,079	64.2	2,636	1,968	4,604	57.2	116,297	65,386	181,683	64.0	2.5
2040 (5)	116,818	64,627	181,445	64.4	2,699	1,997	4,696	57.5	119,517	66,624	186,141	64.2	2.5
2041	119,182	65,673	184,855	64.5	2,747	2,022	4,769	57.6	121,929	67,695	189,624	64.3	2.5
2042	120,717	66,550	187,267	64.5	2,780	2,042	4,822	57.6	123,497	68,592	192,089	64.3	2.5
2043	122,273	67,437	189,711	64.5	2,813	2,063	4,876	57.7	125,086	69,500	194,586	64.3	2.5
2044	123,850	68,337	192,186	64.4	2,846	2,084	4,930	57.7	126,696	70,421	197,116	64.3	2.5
2045	125,447	69,247	194,694	64.4	2,879	2,105	4,985	57.8	128,326	71,352	199,679	64.3	2.5
2046	127,002	70,134	197,136	64.4	2,912	2,126	5,038	57.8	129,914	72,260	202,174	64.3	2.5
2047	128,514	70,996	199,510	64.4	2,944	2,146	5,090	57.8	131,458	73,142	204,600	64.3	2.5
2048	130,045	71,868	201,912	64.4	2,976	2,167	5,143	57.9	133,021	74,034	207,055	64.2	2.5
2049	131,594	72,750	204,344	64.4	3,009	2,187	5,196	57.9	134,602	74,938	209,540	64.2	2.5
2050	133,161	73,643	206,804	64.4	3,042	2,208	5,250	57.9	136,203	75,852	212,054	64.2	2.5
2051	134,681	74,509	209,190	64.4	3,074	2,229	5,302	58.0	137,755	76,738	214,492	64.2	2.5
2052	136,152	75,347	211,499	64.4	3,104	2,248	5,353	58.0	139,257	77,595	216,852	64.2	2.5
2053	137,640	76,193	213,833	64.4	3,136	2,268	5,404	58.0	140,775	78,462	219,237	64.2	2.5
2054	139,143	77,050	216,193	64.4	3,167	2,288	5,456	58.1	142,311	79,338	221,649	64.2	2.5
2055	140,664	77,915	218,579	64.4	3,199	2,309	5,508	58.1	143,863	80,224	224,087	64.2	2.5

(1) The Triangle Expressway interchange with Veridea Parkway is assumed to open January 1, 2017.
(2) Ramp up is applied to the first three years of transaction and revenue impacts associated with new toll zones.
(3) The Triangle Expressway interchange with Morrisville Parkway is assumed to open January 1, 2019.
(4) Complete 540 from NC 55 Bypass to I-40 (Segments 1 & 2) is assumed to open January 1, 2025.
(5) Calendar year 2040 represents the last model year.

4.7 Comparison of Traffic and Revenue Forecasts by Scenario

The following presents a comparison of systemwide annual toll transaction and adjusted toll revenue forecasts for the four study scenarios and the incremental impacts of each phasing option on the Triangle Expressway and Complete 540.

Table 4.16 presents a comparison of annual systemwide transaction forecasts by scenario from FY 2017 through FY 2055, including the impacts of Scenarios 2, 3 and 4 compared with Scenario 1. Also shown at the bottom of the table are the average annual rates of growth between model years (presented as average annual percent change or AAPC).

Scenario 1 transactions are forecast to grow from 47.9 million in FY 2017 to 56.4 million in FY 2019, which represents an AAPC of 8.4 percent. Part of that growth can be attributed to the impacts of the new interchanges at the Veridea Parkway and the Morrisville Parkway. By FY 2025, transactions are forecast to increase to 73.1 million representing an AAPC of 4.4 percent between FY 2019 and FY 2025. Strong growth is expected to continue throughout the forecast period with an AAPC of 3.4 percent between FY 2025 and FY 2030, and an AAPC of 2.1 percent between FY 2030 and FY 2040, resulting in 106.3 million transactions in FY 2040.

Scenario 2 transactions mirror Scenario 1 until the opening of Complete 540 from NC 55 Bypass to US 401 (Segment 1) on January 1, 2025, midway through FY 2025. The estimated impact of the first six months of operation of Segment 1 is an increase of 6.3 million transactions or 8.7 percent over Scenario 1. This impact increases to 15.3 million transactions (20.2 percent) in FY 2026 and to 19.9 million transactions (25.5 percent), in FY 2027. By 2029, the first full year of operation in which no ramp-up factors were applied, Segment 1 of Complete 540 is estimated to have a positive impact on systemwide transactions of 25.3 million (30.3 percent) over Scenario 1.

Under Scenario 3, the opening of Complete 540 from NC 55 Bypass to I-40 (Segments 1 and 2) on January 1, 2025 are forecast to result in an increase of 13.6 million transactions, or 18.6 percent, over Scenario 1. By 2029, the first full year of operation in which no ramp-up factors were applied, Segments 1 and 2 of Complete 540 are anticipated to have a positive impact on systemwide transactions of 55.2 million (66.1 percent) over Scenario 1.

Scenario 4 transactions match Scenario 3 until the opening of Complete 540 from I-40 to Knightdale Bypass (Segment 3) on January 1, 2030. The estimated impact of Segments 1, 2 and 3 in FY 2030 is an increase of 78.9 million transactions, or 91.5 percent, over Scenario 1. By 2034, the first full year of operation in which no ramp-up factors were applied, Segments 1, 2 and 3 of Complete 540 are estimated to have a combined positive impact on systemwide transactions of 139.4 million (148.1 percent) over Scenario 1. It should be noted that Segment 3 has six mainline tolling zones while Segments 1 and 2 have only three mainline tolling zones each, despite all three segments having similar distances. This results in Segment 3 having a disproportionate impact on transactions compared to Segments 1 and 2.

Table 4.17 presents a comparison of annual systemwide adjusted toll revenue forecasts by scenario from FY 2017 through FY 2055, including the impacts of Scenarios 2, 3 and 4 compared with Scenario 1. Also, shown at the bottom of the table are the average annual rates of growth between model years (presented as AAPC).

Table 4.16
Comparison of Systemwide Transaction Forecasts by Scenario
(all traffic in thousands)

Fiscal Year	Scenario 1			Scenario 2			Scenario 3			Scenario 4		
	Total Tolled Traffic	Impact of Scenario 2 Compared to Scenario 1		Total Tolled Traffic	Impact of Scenario 3 Compared to Scenario 1		Total Tolled Traffic	Impact of Scenario 4 Compared to Scenario 1		Total Tolled Traffic		
		Impact	% Impact		Impact	% Impact		Impact	% Impact			
2017	47,946	-	-	47,946	-	-	47,946	-	-	47,946		
2018	52,331	-	-	52,331	-	-	52,331	-	-	52,331		
2019	56,387	-	-	56,387	-	-	56,387	-	-	56,387		
2020	60,375	-	-	60,375	-	-	60,375	-	-	60,375		
2021	63,243	-	-	63,243	-	-	63,243	-	-	63,243		
2022	65,779	-	-	65,779	-	-	65,779	-	-	65,779		
2023	68,153	-	-	68,153	-	-	68,153	-	-	68,153		
2024	70,533	-	-	70,533	-	-	70,533	-	-	70,533		
2025	73,054	6,329	8.7	79,383	13,559	18.6	86,613	13,559	18.6	86,613		
2026	75,597	15,259	20.2	90,856	32,788	43.4	108,385	32,788	43.4	108,385		
2027	78,133	19,906	25.5	98,039	42,983	55.0	121,116	42,983	55.0	121,116		
2028	80,761	23,266	28.8	104,028	50,487	62.5	131,248	50,487	62.5	131,248		
2029	83,486	25,296	30.3	108,782	55,162	66.1	138,648	55,162	66.1	138,648		
2030	86,310	26,769	31.0	113,079	58,665	68.0	144,975	78,943	91.5	165,253		
2031	88,633	28,016	31.6	116,649	61,362	69.2	149,995	109,350	123.4	197,983		
2032	90,424	29,011	32.1	119,435	63,175	69.9	153,599	123,864	137.0	214,288		
2033	92,254	30,040	32.6	122,294	65,045	70.5	157,298	133,783	145.0	226,037		
2034	94,124	31,105	33.0	125,230	66,973	71.2	161,097	139,369	148.1	233,493		
2035	96,036	32,208	33.5	128,244	68,962	71.8	164,998	143,137	149.0	239,173		
2036	97,990	33,348	34.0	131,338	71,014	72.5	169,004	147,011	150.0	245,001		
2037	99,988	34,528	34.5	134,515	73,130	73.1	173,118	150,994	151.0	250,981		
2038	102,029	35,748	35.0	137,777	75,314	73.8	177,344	155,088	152.0	257,117		
2039	104,116	37,011	35.5	141,127	77,567	74.5	181,683	159,297	153.0	263,413		
2040	106,251	38,315	36.1	144,566	79,890	75.2	186,141	163,622	154.0	269,873		
2041	108,029	39,231	36.3	147,259	81,596	75.5	189,624	166,892	154.5	274,920		
2042	109,433	39,741	36.3	149,174	82,656	75.5	192,089	169,061	154.5	278,494		
2043	110,856	40,257	36.3	151,113	83,731	75.5	194,586	171,259	154.5	282,115		
2044	112,297	40,781	36.3	153,077	84,819	75.5	197,116	173,486	154.5	285,782		
2045	113,757	41,311	36.3	155,067	85,922	75.5	199,679	175,741	154.5	289,497		
2046	115,178	41,827	36.3	157,005	86,996	75.5	202,174	177,937	154.5	293,115		
2047	116,560	42,329	36.3	158,889	88,040	75.5	204,600	180,072	154.5	296,633		
2048	117,959	42,837	36.3	160,796	89,096	75.5	207,055	182,233	154.5	300,192		
2049	119,375	43,351	36.3	162,726	90,165	75.5	209,540	184,420	154.5	303,795		
2050	120,807	43,871	36.3	164,678	91,247	75.5	212,054	186,633	154.5	307,440		
2051	122,196	44,376	36.3	166,572	92,296	75.5	214,492	188,779	154.5	310,975		
2052	123,540	44,864	36.3	168,404	93,312	75.5	216,852	190,855	154.5	314,395		
2053	124,899	45,357	36.3	170,256	94,338	75.5	219,237	192,955	154.5	317,854		
2054	126,273	45,856	36.3	172,129	95,376	75.5	221,649	195,077	154.5	321,350		
2055	127,662	46,361	36.3	174,023	96,425	75.5	224,087	197,223	154.5	324,885		
Average Annual Percent Change (AAPC)												
2017-2019	8.4%			8.4%			8.4%			8.4%		
2019-2025	4.4%			5.9%			7.4%			7.4%		
2025-2030	3.4%			7.3%			10.9%			13.8%		
2030-2040	2.1%			2.5%			2.5%			5.0%		

Table 4.17
Comparison of Systemwide Adjusted Toll Revenue Forecasts by Scenario
(all revenue in thousands of \$)

Fiscal Year	Scenario 1			Scenario 2			Scenario 3			Scenario 4		
	Adjusted Toll Revenue	Impact of Scenario 2 Compared to Scenario 1		Adjusted Toll Revenue	Impact of Scenario 3 Compared to Scenario 1		Adjusted Toll Revenue	Impact of Scenario 4 Compared to Scenario 1		Adjusted Toll Revenue		
		Impact	% Impact		Impact	% Impact		Impact	% Impact			
2017	\$ 44,344	\$ -	-	\$ 44,344	\$ -	-	\$ 44,344	\$ -	-	\$ 44,344		
2018	49,389	-	-	49,389	-	-	49,389	-	-	49,389		
2019	54,334	-	-	54,334	-	-	54,334	-	-	54,334		
2020	59,316	-	-	59,316	-	-	59,316	-	-	59,316		
2021	63,637	-	-	63,637	-	-	63,637	-	-	63,637		
2022	67,790	-	-	67,790	-	-	67,790	-	-	67,790		
2023	71,856	-	-	71,856	-	-	71,856	-	-	71,856		
2024	76,269	-	-	76,269	-	-	76,269	-	-	76,269		
2025	80,964	5,406	6.7	86,370	11,509	14.2	92,473	11,509	14.2	92,473		
2026	85,839	13,288	15.5	99,127	28,318	33.0	114,156	28,318	33.0	114,156		
2027	91,107	17,847	19.6	108,954	38,194	41.9	129,301	38,194	41.9	129,301		
2028	96,565	21,416	22.2	117,980	46,041	47.7	142,606	46,041	47.7	142,606		
2029	102,329	23,950	23.4	126,278	51,690	50.5	154,018	51,690	50.5	154,018		
2030	108,601	26,115	24.0	134,716	56,616	52.1	165,217	69,399	63.9	178,000		
2031	114,720	28,100	24.5	142,820	60,885	53.1	175,605	91,602	79.8	206,321		
2032	120,558	29,884	24.8	150,442	64,429	53.4	184,987	104,129	86.4	224,687		
2033	126,587	31,832	25.1	158,419	68,282	53.9	194,869	114,349	90.3	240,936		
2034	132,900	33,910	25.5	166,810	72,292	54.4	205,192	122,110	91.9	255,011		
2035	139,596	36,088	25.9	175,683	76,488	54.8	216,084	128,734	92.2	268,330		
2036	146,426	38,309	26.2	184,735	80,849	55.2	227,275	135,505	92.5	281,931		
2037	152,780	40,596	26.6	193,376	85,237	55.8	238,017	142,495	93.3	295,275		
2038	158,755	43,015	27.1	201,770	89,906	56.6	248,661	150,049	94.5	308,805		
2039	165,028	45,571	27.6	210,599	94,884	57.5	259,912	158,086	95.8	323,114		
2040	171,692	48,339	28.2	220,032	100,260	58.4	271,953	166,556	97.0	338,248		
2041	177,562	50,377	28.4	227,939	104,375	58.8	281,937	172,947	97.4	350,508		
2042	182,132	51,765	28.4	233,897	107,186	58.9	289,318	177,602	97.5	359,734		
2043	186,401	53,143	28.5	239,544	109,999	59.0	296,400	182,491	97.9	368,893		
2044	190,747	54,440	28.5	245,187	112,723	59.1	303,470	187,097	98.1	377,844		
2045	195,185	55,905	28.6	251,090	115,759	59.3	310,944	191,957	98.3	387,143		
2046	199,591	57,353	28.7	256,943	118,756	59.5	318,347	196,893	98.6	396,484		
2047	203,979	58,709	28.8	262,688	121,650	59.6	325,629	201,862	99.0	405,841		
2048	208,454	60,160	28.9	268,614	124,720	59.8	333,174	207,106	99.4	415,560		
2049	212,961	61,604	28.9	274,565	127,774	60.0	340,735	212,053	99.6	425,014		
2050	217,581	63,079	29.0	280,660	130,894	60.2	348,475	217,029	99.7	434,610		
2051	222,189	64,543	29.0	286,732	133,949	60.3	356,138	222,095	100.0	444,283		
2052	226,759	65,990	29.1	292,749	136,947	60.4	363,706	227,159	100.2	453,918		
2053	231,432	67,496	29.2	298,928	140,041	60.5	371,473	232,540	100.5	463,972		
2054	236,187	68,948	29.2	305,136	143,076	60.6	379,264	237,529	100.6	473,717		
2055	241,019	70,460	29.2	311,479	146,277	60.7	387,297	242,841	100.8	483,860		
Average Annual Percent Change (AAPC)												
2017-2019	10.7%			10.7%			10.7%			10.7%		
2019-2025	6.9%			8.0%			9.3%			9.3%		
2025-2030	6.0%			9.3%			12.3%			14.0%		
2030-2040	4.7%			5.0%			5.1%			6.6%		

Scenario 1 adjusted toll revenue is forecast to grow from \$44.3 million in FY 2017 to 54.3 million in FY 2019, which represents at an AAPC of 10.7 percent, reflecting the combined impact traffic growth and annual toll increases. Part of that growth can be attributed to the impacts of the new interchanges at Veridea Parkway and Morrisville Parkway. By FY 2025, revenue is forecast to increase to \$81.0 million representing an AAPC of 6.9 percent between FY 2019 and FY 2025. Strong growth is expected to continue throughout the forecast period with an AAPC of 6.0 percent between FY 2025 and FY 2030, and an AAPC of 4.7 percent between FY 2030 and FY 2040, resulting in \$171.7 million in FY 2040.

Adjusted toll revenue is the same for all Scenarios until FY 2025 when Complete 540 opens. Under Scenario 2, the opening of Complete 540 from NC 55 Bypass to US 401 (Segment 1) in FY 2025 has a positive revenue impact of \$5.4 million or 6.7 percent compared with Scenario 1. By 2029, the first full year of operation to which no ramp-up factors were applied, Segment 1 of Complete 540 is estimated to have a positive impact on systemwide adjusted toll revenue of \$24.0 million (23.4 percent) over Scenario 1.

Under Scenario 3, the opening of Complete 540 from NC 55 Bypass to I-40 (Segments 1 and 2) in FY 2025 has a positive revenue impact of \$11.5 million (14.2 percent) compared with Scenario 1. By 2029, the first full year of operation to which no ramp-up factors were applied, Segment 1 of Complete 540 is estimated to have a positive impact on systemwide adjusted toll revenue of \$51.7 million (50.5 percent) over Scenario 1.

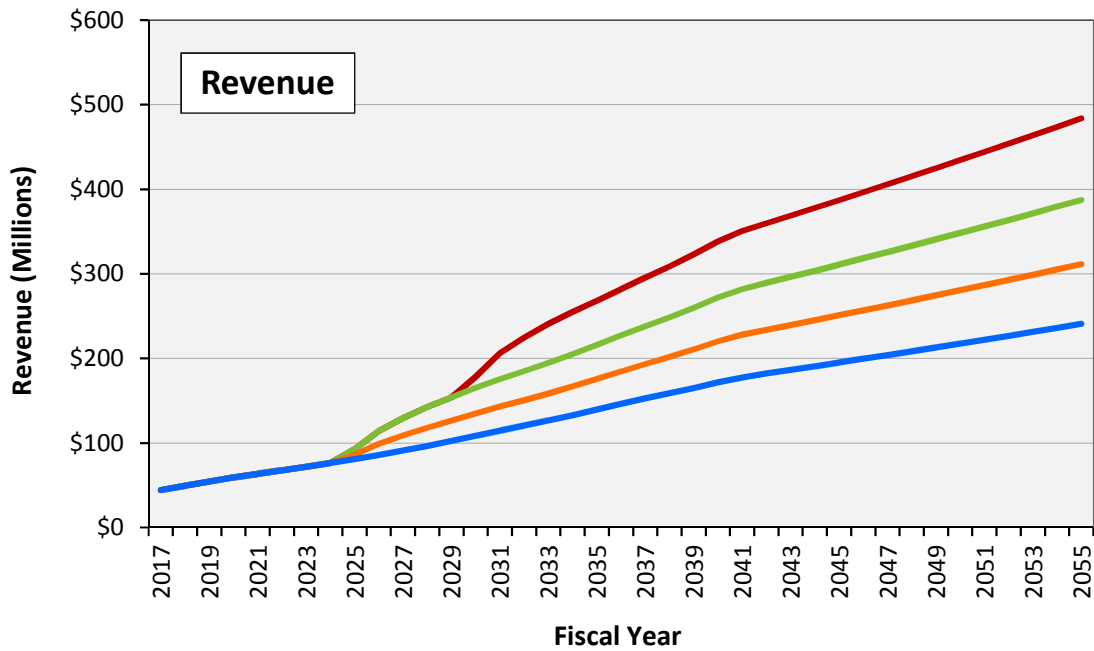
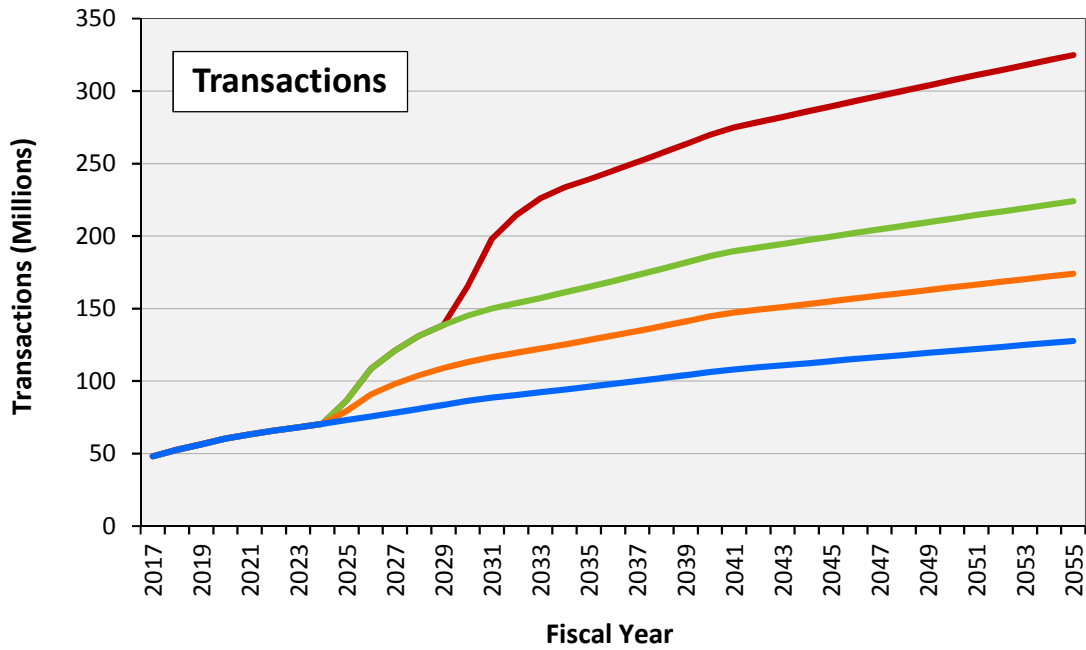
Scenario 4 annual adjusted toll revenues match Scenario 3 until the extension of Complete 540 from I-40 to Knightdale Bypass (Segment 3) on January 1, 2030. The estimated combined impact of Segments 1, 2 and 3 in FY 2030 is an increase of \$69.4 million, or 91.5 percent, over Scenario 1. By 2034, the first full year of operation to which no ramp-up factors were applied, Segments 1, 2 and 3 of Complete 540 are estimated to have a combined positive impact on systemwide adjusted toll revenue of \$122.1 million (91.1 percent) over Scenario 1.

Figure 4.10 presents graphical comparisons of systemwide annual toll transaction and adjusted toll revenue forecasts for the four study scenarios.

The previously described systemwide traffic and revenue impacts of Complete 540 are comprised of transactions at toll zones on the new segments as well as new transactions on the existing portions of the Triangle Expressway as Complete 540 provides improved access. **Table 4.18** presents transactions and adjusted toll revenue for fiscal years 2025, 2030 and 2040 from only Triangle Expressway toll zones under each of the four study scenarios. The impacts shown represent new Triangle Expressway transactions and revenue induced by the improved access provided by Complete 540.

Complete 540 from NC 55 Bypass to US 401 under Scenario 2 is forecast to add an additional 1.5 million transactions (2.1 percent) on the Triangle Expressway in FY 2025. That impact increases to 4.2 million (4.9 percent) in FY 2030 and 7.4 million (7.0 percent) in FY 2040.

Complete 540 from NC 55 Bypass to I-40 under Scenario 3 is forecast to add an additional 2.3 million transactions (3.2 percent) on the Triangle Expressway in FY 2025 and 6.3 million



**FISCAL YEAR TRANSACTIONS AND ADJUSTED
TOLL REVENUE FORECASTS BY SCENARIO**



FIGURE 4.10

transactions (7.3 percent) in FY 2030. By 2040 that impact increases to 9.4 million (8.9 percent). Scenario 3 impacts on Triangle Expressway transactions are approximately 50 percent greater than those estimated for Scenario 2 in FY 2025 and 2030, and approximately 30 percent greater in 2040.

Table 4.18
Transaction and Adjusted Toll Revenue Impacts of Complete 540 on the Triangle Expressway
(transactions and revenue in thousands)

Fiscal Year	Scenario 1	Scenario 2 Compared to Scenario 1		Scenario 2	Scenario 3 Compared to Scenario 1		Scenario 3	Scenario 4 Compared to Scenario 1		Scenario 4
		Impact	% Impact		Impact	% Impact		Impact	% Impact	
Transactions on the Triangle Expressway										
2025	73,054	1,503	2.1	74,557	2,310	3.2	75,364	2,310	3.2	75,364
2030	86,310	4,252	4.9	90,562	6,265	7.3	92,575	5,976	6.9	92,286
2040	106,251	7,386	7.0	113,637	9,449	8.9	115,700	8,956	8.4	115,207
Adjusted Toll Revenue Generated by the Triangle Expressway										
2025	\$ 80,964	\$ 1,399	1.7	\$ 82,363	\$ 2,302	2.8	\$ 83,266	\$ 2,302	2.8	\$ 83,266
2030	108,601	4,483	4.1	113,085	6,987	6.4	115,588	6,580	6.1	115,181
2040	171,692	10,010	5.8	181,703	13,500	7.9	185,192	12,470	7.3	184,162

Under Scenario 4, Complete 540 from NC 55 Bypass to the Knightdale Bypass is forecast to add 6.0 million transactions (6.9 percent) on the Triangle Expressway in FY 2030 and 9.0 million transactions (8.4 percent) in 2040.

Adjusted toll revenue impacts, on a percent basis, are slightly smaller than the corresponding transaction impacts for each scenario, but show similar trends throughout. This is due to the differing toll rates on a per-mile basis at the impacted toll zones.

Table 4.19 presents a comparison of estimated transactions and adjusted toll revenue generated on Complete 540 Segment 1 under Scenario 2 and Scenario 3 for fiscal years 2025, 2030 and 2040. Also shown is a comparison of estimated transactions and adjusted toll revenue generated on Complete 540 Segment 2 under Scenario 3 and Scenario 4. In both cases the impacts shown represent new transactions and revenue generated by the improved access provided by the opening of an adjacent segment of Complete 540.

Table 4.19
Transaction and Revenue Impacts of Additional Segments on Complete 540
(transactions and revenue in thousands)

Fiscal Year	Scenario 3 Compared to Scenario 2 on Segment 1 (NC 55 to U.S. 401)				Scenario 4 Compared to Scenario 3 on Segment 2 (U.S. 401 to I-40)			
	Scenario 2	Impact	% Impact	Scenario 3	Scenario 3	Impact	% Impact	Scenario 4
Transactions on Segment 1								
2025	8,872	2,202	24.8	11,074	8,843	-	-	8,843
2030	22,517	6,512	28.9	29,029	23,371	1,754	7.5	25,125
2040	30,929	7,962	25.7	38,891	31,550	3,638	11.5	35,189
Revenue on Segment 1								
2025	\$ 7,462	\$ 1,836	24.6	\$ 9,298	\$ 7,270	\$ -	-	\$ 7,270
2030	21,631	6,137	28.4	27,768	21,868	1,725	7.9	23,594
2040	38,329	9,670	25.2	47,999	38,775	4,474	11.5	43,249
Revenue on Segment 2								

Transactions on Segment 1 in FY 2025 are estimated to increase from 8.9 million under Scenario 2 to 11.1 million under Scenario 3. This represents a positive impact of 2.2 million (24.8 percent) on Segment 1 transactions. This impact increases to 6.5 million (28.9 percent) in FY 2030 and to 8.0 million (25.7 percent) in FY 2040.

Transactions on Segment 2 in FY 2030 are estimated to increase from 23.4 million under Scenario 3 to 25.1 million under Scenario 3. This represents a positive impact of 1.8 million (7.5 percent) on Segment 1 transactions. This impact increases to 3.6 million (11.5 percent) in FY 2040.

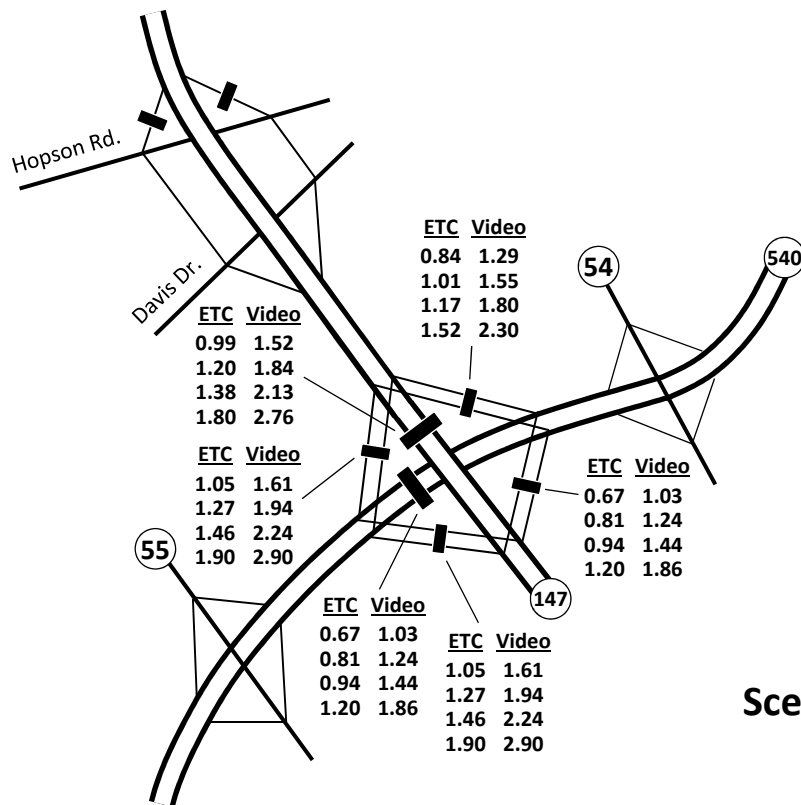
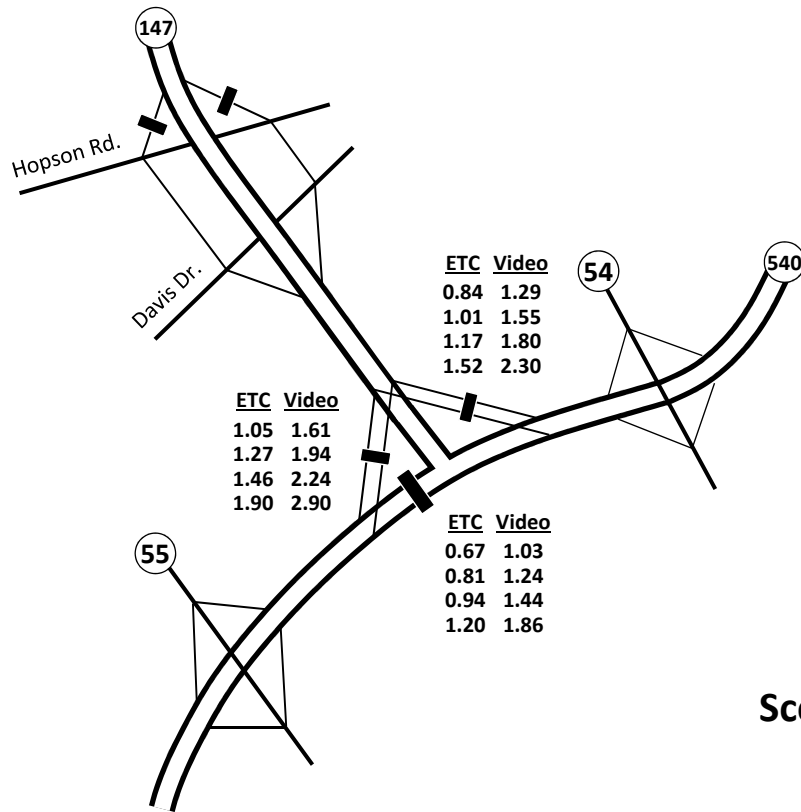
On a percent basis, revenue impacts for both comparisons are nearly identical to the transaction impacts described above. This is due to use of a common per-mile toll rate and mainline toll zones between each interchange on all three segments of Complete 540.

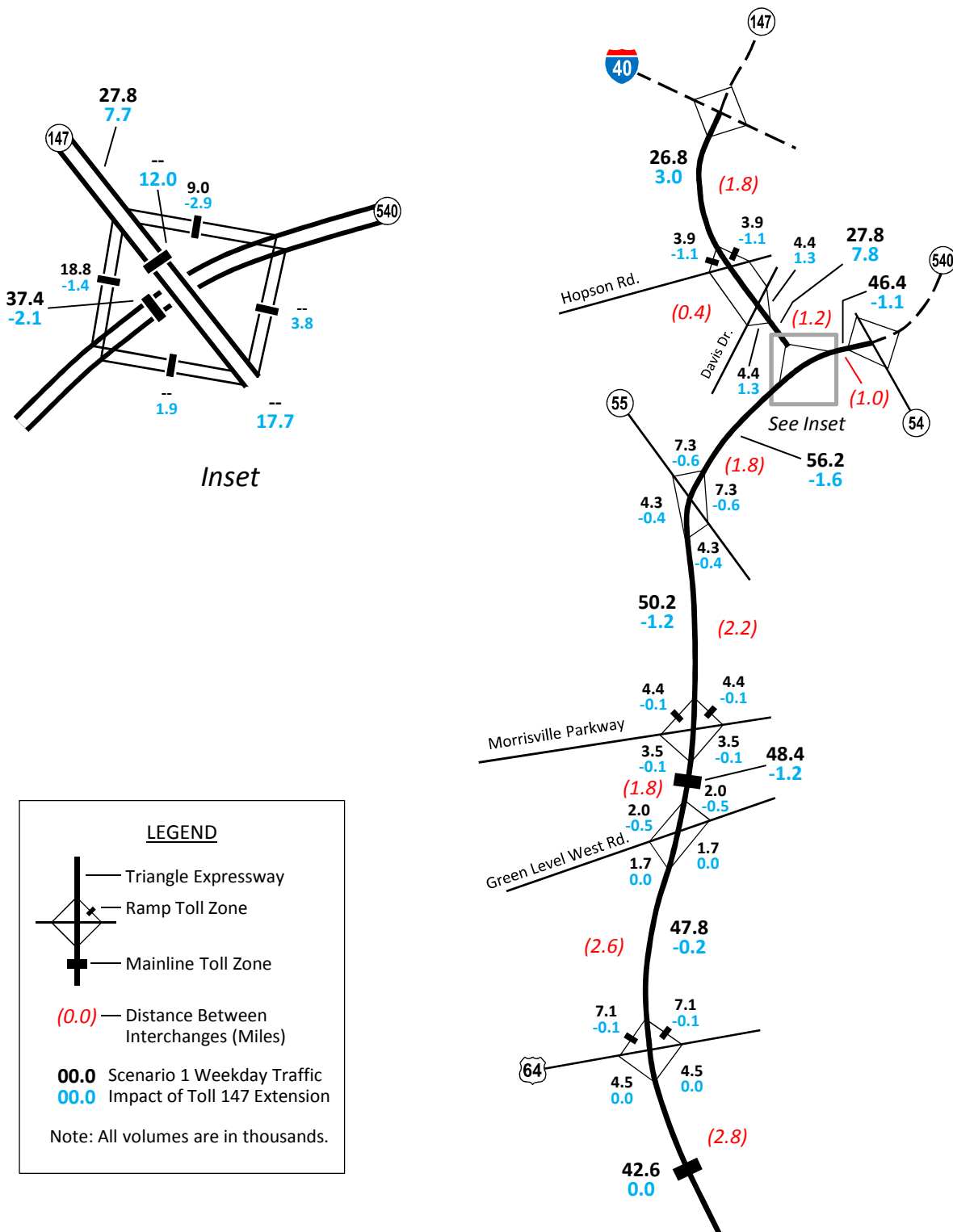
4.8 Scenario 1.1: Triangle Expressway Toll 147 Extension

This scenario is a sensitivity test of Scenario 1, consisting of adding a tolled extension of NC 147 southward from the Triangle Expressway to McCrimmon Parkway in Morrisville. The Toll 147 Extension is assumed to open January 1, 2019. The project location and general alignment are illustrated in Figure 1.1. The existing Toll 147/Toll 540 Interchange would be expanded to include all movements between Toll 540 and Toll 147 as seen in **Figure 4.11**. This figure provides a comparison of available movements and corresponding toll rates at the existing Toll 147 interchange with Toll 540 and the modified interchange assumed for this scenario. Toll rates are shown by method of payment for each toll zone for calendar years 2019, 2025, 2030 and 2040.

Figure 4.12 shows the average weekday traffic on the Triangle Expressway at 2025 levels under Scenario 1 and the corresponding impacts of the Toll 147 Extension at each location. The Toll 147 Extension, south of Toll 540, is forecast to carry approximately 17,700 vehicles on an average weekday in 2025. Of this traffic, 12,000 vehicles pass through the new mainline toll location on Toll 147; 1,900 access the Extension via the Toll 540 ramps to/from the south; and 3,800 access the Extension via the Toll 540 ramps to/from the north. The Toll 147 Extension provides improved access to points in the Morrisville area resulting in a reduction of 2,200 vehicles at the Hopson Road ramps; 2,900 vehicles on the existing Toll 147/Toll 540 interchange ramps to/from the north; and 1,400 vehicles on the existing Toll 147/Toll 540 interchange ramps to/from the south. Smaller negative impacts can be seen on Triangle Expressway ramps at the interchanges with NC 55, the Morrisville Parkway, Green Level West Road and US 64. No traffic impacts are forecast south of US 64 as a result of the Toll 147 Extension.

Table 4.20 presents a comparison of transaction and adjusted toll revenue forecasts between Scenario 1 and Scenario 1.1. The impact of the Toll 147 Extension on Triangle Expressway transactions ranges from 461,000 (0.8 percent) in FY 2019, to 2.2 million (3.1 percent) in 2025; 2.7 million (3.1 percent) in FY 2030; and 5.2 million (4.9 percent) in FY 2040. The impact of the Toll 147 Extension on Triangle Expressway adjusted toll revenue ranges from \$744,000 (1.4 percent) in FY 2019; to \$4.4 million (5.4 percent) in 2025; \$5.9 million (5.5 percent) in FY 2030; and 14.2 million (6.6 percent) in FY 2040.





TRIANGLE EXPRESSWAY: 2025 WEEKDAY TRAFFIC IMPACTS DUE TO TOLL 147 EXTENSION

Table 4.20
Transaction and Revenue Impacts of the Toll 147 Extension on the Triangle Expressway
(all traffic in thousands)

Fiscal Year	Total Tolled Traffic			Adjusted Toll Revenue				
	Scenario 1	Impact	% Impact	Scenario 1.1	Scenario 1	Impact	% Impact	Scenario 1.1
2017	47,946	-	-	47,946	\$ 44,344	\$ -	-	\$ 44,344
2018	52,331	-	-	52,331	49,389	-	-	49,389
2019	56,387	461	0.8	56,848	54,334	744	1.4	55,077
2020	60,375	1,121	1.9	61,496	59,316	1,854	3.1	61,170
2021	63,243	1,481	2.3	64,724	63,637	2,547	4.0	66,184
2022	65,779	1,755	2.7	67,534	67,790	3,129	4.6	70,919
2023	68,153	1,936	2.8	70,089	71,856	3,573	5.0	75,429
2024	70,533	2,079	2.9	72,612	76,269	3,958	5.2	80,227
2025	73,054	2,234	3.1	75,288	80,964	4,373	5.4	85,337
2026	75,597	2,355	3.1	77,951	85,839	4,724	5.5	90,563
2027	78,133	2,436	3.1	80,569	91,107	4,993	5.5	96,100
2028	80,761	2,521	3.1	83,282	96,565	5,275	5.5	101,840
2029	83,486	2,609	3.1	86,095	102,329	5,589	5.5	107,917
2030	86,310	2,701	3.1	89,011	108,601	5,938	5.5	114,539
2031	88,633	2,852	3.2	91,485	114,720	6,422	5.6	121,141
2032	90,424	3,067	3.4	93,490	120,558	7,043	5.8	127,601
2033	92,254	3,292	3.6	95,546	126,587	7,717	6.1	134,304
2034	94,124	3,528	3.7	97,652	132,900	8,442	6.4	141,342
2035	96,036	3,776	3.9	99,812	139,596	9,216	6.6	148,812
2036	97,990	4,037	4.1	102,027	146,426	10,047	6.9	156,473
2037	99,988	4,309	4.3	104,297	152,780	10,946	7.2	163,726
2038	102,029	4,596	4.5	106,625	158,755	11,938	7.5	170,694
2039	104,116	4,896	4.7	109,013	165,028	13,017	7.9	178,045
2040	106,251	5,211	4.9	111,462	171,692	14,175	8.3	185,867
2041	108,029	5,407	5.0	113,435	177,562	15,003	8.4	192,565
2042	109,433	5,477	5.0	114,910	182,132	15,413	8.5	197,545
2043	110,856	5,548	5.0	116,404	186,401	15,777	8.5	202,178
2044	112,297	5,620	5.0	117,917	190,747	16,148	8.5	206,895
2045	113,757	5,693	5.0	119,450	195,185	16,514	8.5	211,699
2046	115,178	5,765	5.0	120,943	199,591	16,877	8.5	216,467
2047	116,560	5,834	5.0	122,394	203,979	17,251	8.5	221,230
2048	117,959	5,904	5.0	123,863	208,454	17,631	8.5	226,085
2049	119,375	5,975	5.0	125,349	212,961	18,017	8.5	230,978
2050	120,807	6,046	5.0	126,853	217,581	18,409	8.5	235,991
2051	122,196	6,116	5.0	128,312	222,189	18,799	8.5	240,988
2052	123,540	6,183	5.0	129,723	226,759	19,187	8.5	245,946
2053	124,899	6,251	5.0	131,150	231,432	19,581	8.5	251,013
2054	126,273	6,320	5.0	132,593	236,187	19,983	8.5	256,171
2055	127,662	6,389	5.0	134,051	241,019	20,394	8.5	261,413

Average Annual Percent Change (AAPC)

2017-2019	8.4%	8.9%	10.7%	11.4%
2019-2025	4.4%	4.8%	6.9%	7.6%
2025-2030	3.4%	3.4%	6.0%	6.1%
2030-2040	2.1%	2.3%	4.7%	5.0%

4.9 Fiduciary Disclaimer

Current accepted professional practices and procedures were used in the development of these updated traffic and revenue forecasts. However, as with any forecast of the future, there may be differences between forecasted and actual results caused by events and circumstances beyond the control of CDM Smith. In formulating its forecasts, CDM Smith has reasonably relied upon the accuracy and completeness of information provided (both written and oral) by the NCDOT/NCTA and other local and state agencies. CDM Smith also has relied upon the reasonable assurances of some independent parties and is not aware of any facts that would make such information misleading.

CDM Smith has made qualitative judgments related to several key variables in the development and analysis of the traffic and revenue forecasts that must be considered as a whole; therefore, selecting portions of any individual result without consideration of the intent of the whole may create a misleading or incomplete view of the results and the underlying methodologies used to obtain the results. CDM Smith gives no opinion as to the value or merit to partial information extracted from this report.

All forecasts and projections reported herein are based on CDM Smith's experience and judgment and on a review of information obtained from multiple state and local agencies, including NCDOT/NCTA. These estimates and projections may not be indicative of actual or future values, and are therefore subject to substantial uncertainty. Future developments cannot be predicted with certainty, and may affect the forecasts or projections expressed in this report, such that CDM Smith does not specifically guarantee or warrant any forecasts or projections contained within this report.

While CDM Smith believes that some of the projections or other forward-looking statements contained within the report are based on reasonable assumptions as of the date in the report, such forward looking statements involve risks and uncertainties that may cause actual results to differ materially from the results predicted. Therefore, following the date of this report, CDM Smith will take no responsibility or assume any obligation to advise of changes that may affect its assumptions contained within the report, as they pertain to: socioeconomic and demographic forecasts, proposed residential or commercial land use development projects and/or potential improvements to the regional transportation network.

CDM Smith is not, and has not been, a municipal advisor as defined in Federal law (the Dodd Frank Bill) to NCDOT/NCTA and does not owe a fiduciary duty pursuant to Section 15B of the Exchange Act to NCDOT/NCTA with respect to the information and material contained in this report. CDM Smith is not recommending and has not recommended any action to NCDOT/NCTA. NCDOT/NCTA should discuss the information and material contained in this report with any and all internal and external advisors that it deems appropriate before acting on this information.